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NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

THESIS

MANAGING COMMUNICATIONS WITH EXPERTS IN GEOGRAPHICALLY DISTRIBUTED COLLABORATIVE NETWORKS

by

Joseph E. Delaney

March 2009

Thesis Advisor:	Alex Bordetsky
Co-Advisor:	Michael Clement

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13. ABSTRACT (maximum 200 words)

The idea of communication through collaboration is not new, however, the need to collaborate efficiently with subject matter experts has become essential towards establishing a competitive advantage among individuals, groups, and organizations. As networks expand, organizations flatten, and globalization continues, geographically distributed collaborative networks have become pervasive and are more common as a way of conducting daily business and resolving problems. Developing the ability to effectively manage communications with experts, through a collaboration strategy to maximize this new environment, has rapidly become a critical skill set. While people are becoming inundated with collaboration technologies, the assurance needed that strong connections are formed, regardless of the technological tools utilized, requires an understanding of social science fundamentals. This further requires an understanding of network science fundamentals. Understanding the intricacies involved in managing communications with experts in geographically distributed collaborative networks is extremely important but under-researched. This thesis combines social and network science fundamentals to develop a strategy for managing communications with experts in geographically distributed collaborative networks.

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MANAGING COMMUNICATIONS WITH EXPERTS IN A GEOGRAPHICALLY DISTRIBUTED COLLABORATIVE NETWORK

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ABSTRACT

The idea of communication through collaboration is not new; however, the need to collaborate efficiently with subject matter experts has become essential towards establishing a competitive advantage among individuals, groups, and organizations. As networks expand, organizations flatten, and globalization continues, geographically distributed collaborative networks have become pervasive and are more common as a way of conducting daily business and resolving problems. Developing the ability to effectively manage communications with experts, through a collaboration strategy designed to maximize this new environment, has rapidly become a critical skill set. While people are becoming inundated with collaboration technologies, the assurance needed that strong connections are formed, regardless of the technological tools utilized, requires an understanding of social science fundamentals. This further requires an understanding of network science fundamentals. Understanding the intricacies involved in managing communications with experts in a geographically distributed collaborative network is extremely important but under-researched. This thesis combines social and network science fundamentals to develop a strategy for managing communications with experts in geographically distributed collaborative networks.

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I. INTRODUCTION

A. BACKGROUND

The idea of communication through collaboration is not new; however, the need to collaborate efficiently with subject matter experts has become essential towards establishing a competitive advantage among individuals, groups, and organizations. As networks expand, organizations flatten, and globalization continues, geographically distributed collaborative networks have become pervasive and are more common as a way of conducting daily business and resolving problems. Developing the ability to effectively manage communications with experts, through a collaborative strategy designed to maximize this new environment, has rapidly become a critical skill set. While people are becoming inundated with collaboration technologies, the assurance needed that strong connections are formed, regardless of the technological tools utilized, requires an understanding of social science fundamentals. This further requires an understanding of network science fundamentals. This thesis combines social and network science fundamentals to develop a strategy for managing communications with experts in geographically distributed collaborative networks.

B. RESEARCH QUESTION

In this thesis the hypothesis is put forth that a collaborative strategy, embodied with key principles from social and network science, will enable the effective management of communications with experts in geographically distributed collaborative networks. Researchers O'Leary, et al. (2008), authors of *"A Surprising Truth About Geographically Dispersed Teams"*, consider this research area to be timely given that organizations are scaling back and transitioning to tapping into their extended networks to find expertise. Through this research the hypothesis will be analyzed along with the null hypothesis that a collaborative strategy has no impact on the management of communications with experts in geographically distributed collaborative networks regardless of the presence of key social and network science principles. The primary

research question being addressed is as follows: What criteria must be present in a collaborative strategy to form an effective method to managing communications with experts in geographically distributed collaborative networks?

C. POTENTIAL BENEFIT

This research is based on the idea that communication through collaboration is not new and focuses on the need to collaborate efficiently with experts as the collaborative environment continues to evolve. The skill set needed to excel in a rapidly evolving collaborative environment requires a combination of key social and network science principles. This thesis explores the idea of collaboration focused on the management of communications with experts; people who have developed and proven skills in their subject matter areas, in geographically distributed collaborative networks. It will have direct application to any organization seeking to understand the changing nature of communications with experts in geographically distributed collaborative networks.

D. METHODOLOGY

Research will be accomplished through a review of literature focused on the social and network science enablers and obstacles to collaboration. Additionally, it will include interviews with a sample population from the Navy's Security Cooperation Community (SCC). Lastly, feedback from the Navy's SCC will be incorporated to develop a collaborative strategy for the Naval Postgraduate School's (NPS) Center for Network Innovation and Experimentation (CENETIX) Maritime Interdiction Operation (MIO) geographically distributed expert team of planners. Work will be coordinated with the Space and Naval Warfare Systems Center San Diego (SSC-SD) on the development of a collaborative strategy focused on the management of communications among expert planners. This approach will be used to gather additional data, identify elements necessary to answer the thesis research question, and ultimately serve as a platform to identify the conditions that lend towards the development of an effective collaboration strategy. Conditions identified through this methodology will then be applied to the MIO network of planners that currently collaborate through e-mail and teleconference to plan and execute MIO experiments. Throughout this thesis, principles

of Systems Thinking are applied, which views the world as a complex system and explains the importance of understanding how everything in a complex system is interconnected. Additionally, environmental factors that impact the management of communications with experts are closely analyzed and considered.

E. ORGANIZATION OF THESIS

The remainder of this thesis is organized into four chapters. Chapter II provides a literature review focused on the areas of networks, Systems Thinking, and collaboration. This will enable readers to develop a brief understanding of the subject matter before proceeding to the analysis portion of this thesis. Chapter III presents the first analysis area, the Navy's SCC. This author was introduced to the Navy's SCC through NPS course Information Science 4188 Collaborative Technologies. This was chosen as an organization to study because of the author's interest and the representation of the Navy's SCC as an expert organization seeking to become an expert networked organization. Chapter III provides principles that can be rapidly applied to any collaborative organization. Chapter IV presents the second analysis area, the NPS CENETIX MIO planner's network. This author was introduced to the MIO experiment through Dr. Alex Bordetsky, director of the NPS CENETIX laboratory. This was chosen as an organization to study also because of the author's interest. Additionally, it provides a means to test the criteria discovered through the analysis of the Navy's SCC in a controlled atmosphere. Chapter V concludes the thesis with an overview of the material presented and offers a list of future research possibilities providing a roadmap to implementation.

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II. LITERATURE REVIEW

A. INTRODUCTION

A review of literature on the foundational aspects of this research (i.e., networks and collaboration) revealed Albert-Laszlo Barabasi[1] as one of the leading experts. Barabasi began his research in the field of network science during a time when it was unknown, and in conjunction with taking a risk in abandoning his extensive research in the material science field. In *Linked: How Everything Is Connected to Everything Else and What It Means* (Barabasi, 2003), he points out how after immersing himself in algorithms, graphs, and Boolean logic, he realized how little was known about networks. At that point, Barabasi set out to find and understand the organizing principles governing the complex webs in the various facets of life. It didn't take him long to realize that the field of networks was extremely important but significantly under-researched. In *Looking for the Next Big Thing* (Keiger, 2007), Barabasi is quoted as often saying:

> I don't find much satisfaction in taking a problem a lot of people have been working on and doing it better. I do find satisfaction in working on a problem nobody considers a problem yet.

Barabasi's research is renowned among network experts and frequently referenced by others who are considered experts in their own right. This list of who's who of renowned authors includes Fritjof Capra, Duncan Watts, and Malcolm Gladwell[2]. Even before any of these authors began their contributions to their field of expertise, in the 1780s, Leonhard Euler[3], who was considered a true pioneer in the field of network science, invented network theory, a form of abstract mathematics. The review of the

[1] Born March 30, 1967, Albert-Laszlo Barabasi is a Romanian-born Hungarian scientist. He is the former Emil T. Hofmann professor at the University of Notre Dame and current Distinguished Professor and Director of Northeastern University's Center for Network Science.

[2] Fritjof Capra, Ph.D., physicist, and systems theorist, is a founding director of the Center for Ecoliteracy in Berkeley, California. Duncan J. Watts is an Australian professor of sociology at Columbia University and an external faculty member of the Santa Fe Institute. Malcolm Gladwell is a United Kingdom-born; Canadian-raised journalist now based in New York City and has been a staff writer for The New Yorker since 1996.

[3] Leonhard Paul Euler, April 15, 1707 – September 18, 1783, was a pioneering Swiss mathematician and physicist.

literature presented by these founding fathers summarizes that a network consists of nodes and links and lays the foundation for what would later become known as collaboration between two vital aspects of networks – connectors and hubs.

B. NETWORKS

Networks encompass connectors and hubs but also involve clusters – a rarely mentioned aspect of a network. Clusters require only one link between geographically collocated groups that share a common interest. At one point clusters enjoyed the center stage in any discussion involving network science. This evolved during a time when networks were evaluated based on random graphs. With the introduction of Barabasi's work on connectors and hubs, the focus on clusters changed dramatically by introducing a complex rather than random worldview (Barabasi, 2003). For clusters to form a network, a specific connector is required. This is the node, a single point, person, or entity on the network that shares a common interest in more than one cluster. This node's relationship to more than one cluster forms a relationship with the node as the connector. Although this node may be a connector, it is not necessarily a hub. A hub is defined as a super connector. These connectors have an extraordinary number of relationships. In the case of people, a hub would be a person who has an unusually high number of personal associations. In some cases, the person may not be an extravert but may become a hub due to a position, such as a secretary who comes into contact with and forms relationships with a large number of people on a consistent basis. In this case, however, the secretary's boss would usually be defined as the hub and the secretary would be a connector due to the nature of the relationships at each level.

Barabasi described connectors and hubs as "The Fifth Link," where he references the work done by Gladwell in *The Tipping Point* (Gladwell, 2000). He highlights Gladwell's concluding point that connectors are considered the handful of people sprinkled in every walk of life that have an extraordinary knack for making friends and acquaintances. These connectors are critical to the social layer of networks and are the driver for trends, fashions, fads, and other socially influenced movements. He credits connectors as the social thread throughout life that brings people together from different

classes, education levels, and social circles. Of particular note is Barabasi's conclusion that these connectors are present in a wide diversity of complex systems ranging from the economy to the cell. They are the fundamental discovery that completely changed the world of networks that had previously been focused on clusters. Hubs are unique in that they are not as frequently found as connectors in a network, although, they dominate the structure of the network where they exist. Hubs create short paths between any two nodes on a network (Barabasi, 2003). These connectors and hubs are commonly linked to form expert networks. They consist of groups of subject matter experts brought together to conduct research, execute an experiment, or solve a problem requiring specified expertise. While this research presents a critical perspective of the network, it maintains a view of the network as part of any larger system it may affect. To ensure this view is preserved, the idea of Systems Thinking was also researched and applied.

C. SYSTEMS THINKING

The concept of Systems Thinking is based on a holistic means of evaluating relationships of parts of a system. This framework believes that the component parts of a system can be best understood in the context of their relationships with other parts. Systems Thinking focuses on recognizing interconnections between parts of a system and synthesizing them into a cohesive view of the whole (Anderson et al., 1997). The idea of Systems Thinking is to develop the ability to see the world as a complex system, in which it is understood that no one event occurs in isolation. Everything, in a Systems Thinking world, is connected to everything else. This further proposes that if everyone had a holistic view of the world, they would act with long-term interests in the survival of the system (Sterman, 2000). The origin of Systems Thinking emerged during the 1920s simultaneously from several disciplines, pioneered by biologists. This work introduced a new way of thinking about connectedness and relationships (Capra, 1996). Each of the Systems Thinking concepts (i.e., layered models, feedback loops, causal loops, self-organization, adaptation, and synergy) can be ambiguous when defined in isolation. In support of this review, the concepts are defined and applied in the context of the management of communications with experts in geographically distributed collaborative networks.

1. Layered Models

Networks are inherently comprised of layered models that can be seen through a review of network architecture. Communities utilize a diversity of networks to accomplish their daily activities. Their use of networks crosses the physical, biological, and social domains. These networks are built upon each other and carry attributes of dependency for their survival. For example, social networks require information that comes from information networks. These in turn encompass communication networks that reside on physical networks as a medium (National Research Council, 2005).

2. Feedback Loops

The nature of connectedness of networks forms a natural feedback loop. Connectors and hubs rely on this connectedness. Capra (1996) describes a feedback loop as a circular arrangement of connected elements, in which an initial event propagates around the links of the loop, so that each element has an effect on the next, until the last event feeds back the effect into the first element of the cycle. Although this can result in a positive as well as a negative effect, the unintended consequence of a feedback loop is that the first link, described as the input, is affected by the last link, described as the output, resulting in self regulation. According to Capra (1996), self-regulation involves modification of the entire system as the initial effect is modified each time through a series of inputs and outputs.

3. Causal Loops

Although very similar to description of Feedback Loops, Causal Loops help provide an understanding of the complexity of the actions taking place that lead to the feedback. Understanding these individual effects is important when it comes to studying the interrelationships. Senge (1990) emphasizes this with his definition of Systems Thinking that he describes as a framework for seeing interrelationships rather than things and for seeing patterns of change rather than a static picture. Networks have a series of causal loops resulting from the connections created between nodes. These nodes are described as variables in the context of causal loop literature. The relationships established between these variables are determined to represent either positive or

negative links. Positive links means that the two nodes move in the same direction. For example, if two nodes are moving in the same direction, the node where the link starts to decrease will result in the other node also decreasing. Negative links are links in which the nodes change in opposite direction. In this case an increase in one node will cause a decrease in another node (Vega, 2008). Alternatively, a decrease in one node will cause an increase in another node. This concept of causal loops demonstrates the cause and effect of powerful experts in geographically distributed collaborative networks. It also identifies an area for consideration when evaluating network architecture and risk management.

4. Self-Organization

Self-organization is a process of attraction and repulsion in which the internal organization of a system, normally an open system, increases in complexity without being guided or managed by an outside source. Self-organizing systems typically display emergent properties, although this is not a requirement (Vega, 2008).

5. Adaptation

An intrinsic power of networks is the ability for a network to respond to its environment resulting in continuous change. Adaptation learning requires a high rate of feedback from the environment whereas an adaptive response allows a system to respond smoothly to these changes (Cares, 2005). The management of expert hubs and connectors requires that knowledge through adaptation be codified to encourage growth.

6. Synergy

Synergy is foundational to the success of collaboration across geographically distributed collaborative networks. Synergy refers to the phenomenon in which two or more discrete influences or agents acting together create an effect greater than that predicted by knowing only the separate effects of the individual agents (Vega, 2008). As the edge of knowledge and innovation continues to be pushed through globalization, the

next synergistic evolution will be seen in significant breakthroughs across sectors where the assembling of disparate entities will occur that do not naturally appear to go together (Friedman, 2007).

D. COLLABORATION

The nature of the interaction between expert connectors and hubs is referred to as collaboration. Collaboration is the process where two or more people work together to achieve a common objective. This is most generally expected to enable an intellectual endeavor through the sharing of knowledge, learning, and the building of consensus (Merriam Webster, 2008). Collaboration encompasses asynchronous as well as synchronous methods of communication and is supported by a wide range of technological tools. Selection of the right method for collaboration is critical to supporting the efficiency and effectiveness of geographically distributed collaborative networks. While both individuals and organizations often rely on a specific means for collaboration, this can diminish the value of the network. The ultimate value of the network, hence the collaboration, comes from the effectiveness derived from its use (Network Science, 2005). Although the concept of collaboration has been researched in-depth, the application of the enablers of collaboration remains vague. In the area of collaboration across any network, there are a number of areas that must be considered for risk mitigation. However, most of these areas reviewed deal strictly with the physical aspects of the network infrastructure. Globalization, unrestricted warfare, and trust are just three of the environmental areas that are currently having a significant impact on the future of collaboration between experts.

1. Globalization

Globalization is a key driver for the need to have increased collaboration skills. As more businesses start out with a global posture from day one, new jobs are created requiring managers to be effective collaborators. In “The World is Flat”, Thomas Friedman notes:

> The more complex the globalized networks, the more companies will need various forms of coordination and management specifications, compatibility, research and design, etc… The complexity of scientific problems being evaluated today requires a multidisciplinary collaboration effort.

He further emphasizes this growing need and encourages schools to begin embedding the tools and concepts of collaboration into their education process. In some cases, educators have recognized the value in collaboration and have encouraged it on their own prior to its inclusion in their curriculum. For example, Julie Lindsay, from the International School Dhaka, in Bangladesh, and Vicki Davis, from Westwood Schools in Camilla, Georgia utilized Friedman's work to encourage collaboration among their students. In just weeks, they established a "Flat Classroom Project" (http://flatclassroomproject.wikispaces.com/) enabling students across the globe to effectively collaborate on a classroom assignment (Friedman, 2007).

2. Unrestricted Warfare

In today's unrestricted warfare environment, speed is essential to achieving victory through collaboration. General James E. Cartwright, while serving as Commander, United States Strategic Command, stated:

> If an adversary wants to release a cyber virus from Baghdad – and he takes the long route and goes out to geosynchronous orbit and comes back down in Nebraska – he can do it in about 300 milliseconds. How are you going to erect your defense in 300 milliseconds? How are you going to detect that you are under attack and do something about it in 300 milliseconds?

He challenges innovators to not continue to do what has always been done. Through collaboration, decision-making cycles have dramatically increased (Unrestricted Warfare Symposium, 2007).

3. Trust

In dealing with geographically distributed collaborative networks, having an abundance of trust is essential to effective collaboration. Collaboration brings about innovation, which is subsequently fostered through risk taking. Without a high degree of trust, there is no risk taking and hence, no innovation in the collaborative network

(Friedman, 2007). Additionally, effective collaboration, where trust exists, enables speed, enhancing the unrestricted warfare environment. In "*Unconventional Insights for Managing Stakeholder Trust"*, Pirson, et al. (2008) emphasizes the challenges of managing stakeholder trust based on the extensive presence of stakeholders in most organizations. This is undoubtedly true in any geographically distributed organization and must be considered throughout this analysis.

E. SUMMARY

This literature review introduced key authors, researchers, and provided an overview necessary to introduce the hypothesis that communications need to be managed among experts in geographically distributed collaborative networks. Combining research on networks and collaboration, coupled with the principles of Systems Thinking, sets the stage for the analysis done on the first organization of interest, the Navy's SCC. The next chapter, International Bench, presents an analysis designed to encapsulate the research presented in the literature review and demonstrate the value of the area chosen for research.

III. INTERNATIONAL BENCH

A. INTRODUCTION

This section presents an analysis and design for managing communications with experts in a geographically distributed collaborative network, the Navy's component of the Security Cooperation Community (SCC). It introduces International Bench, a new initiative designed to provide a web-based collaborative strategy for members of the military and civilian employees of the United States Government who are involved in the planning and execution of security cooperation activities (e.g., sales, information exchange, cooperative development projects, etc.) with foreign countries. Collaborative strategies utilize and exist in technologies designed to assist groups of people involved in common tasks working together to achieve their goals. Because International Bench presents a newly created collaborative strategy, this analysis does not have any applied or military research literature directly associated with it. However, advances in collaborative technologies demonstrated in current applications such as Microsoft Groove, Internet Workspace, Jabber, Multipoint Video Conferencing, Instant Messaging, and other advanced collaboration technologies offer significant insight towards defining a vision and future capability for International Bench. Before presenting the analysis, an understanding about the focus organization – the Navy's SCC will prove to be useful.

The Navy's SCC is a component of the larger Department of Defense (DoD) International Cooperation program overseen by the Under Secretary of Defense for Acquisition, Technology, and Logistics. The International Cooperation program's stakeholders include all the Services, the Office of the Secretary of Defense, and the Defense Security Cooperation Agency. They are ultimately concerned with the security of the United States and those activities conducted with allies and friendly nations that involve security matters. DoD focuses on activities necessary to build relationships that promote specified U.S. interests, build allied and friendly nation capabilities for self-defense and coalition operations, and provide U.S. forces with peacetime and contingency access (DSCA, 2007).

All members of the SCC perform, to varying degrees, the following specific activities towards the achievement of these goals (OSD, 2007):

• National Representation - Provide direct support and representation for all international cooperative matters.

• International Armaments Cooperation - Facilitate international armaments cooperation with allies, friendly foreign countries, and industry in concert with the DoD policy and the National Security Strategy.

• Security Assistance and Training - Facilitate foreign military sales, leases, grants of defense articles and services, and associated training and education of allies and friendly foreign militaries.

• International Research, Development, Test & Evaluation (RDT&E) of Technology and Equipment - Recommend positions on international RDT&E, procurement, exports, & logistics matters.

• International Acquisition of Defense Systems and Equipment - Advocate international cooperation early in component-unique and joint acquisition programs to meet future coalition requirements and resolve international issues associated with acquisition efforts.

At the time of this analysis, no formal or informal connections existed that enabled members of the SCC to collaborate effectively. A common operating environment (i.e., telephone, internet, e-mail, etc.) was available to enable basic interaction between members. Although promoting cooperation between international parties is the focus of the SCC business, internal interactions and cooperation between community members is even more critical to performance. Members of the SCC develop knowledge through experience over time and are supported by a network of professional relationships established independently by each community member. Because they must constantly apply judgment, discretion, and careful evaluation of issues and problems due to the nature and ramifications of unfavorable results caused by adverse actions, they are especially worried about doing the right things on a day-to-day basis. This reflects the emphasis placed on the SCC by the Office of the Secretary of Defense that states:

> …personnel must ensure that their international cooperation related activities fully comply with the wide array of statutes, directives, instructions, regulations, and policies that govern DoD armaments cooperation efforts. Prior consultation with DoD international program organizations (including legal counsel)…is the most effective way to comply with the specific legal and policy requirements that may apply to a given armaments cooperation initiative under consideration. (OUSD, 2006)

Palos (2007) points out that members of the SCC are committed to identifying and making recommendations for cooperative opportunities with the host nation, identifying points of contact, and suggesting timing or lines of reasoning in presenting a U.S. position. This requires them to frequently apply judgment in isolation because no one else in DoD may have the in-country perspective and unique insight of that member or office. The SCC leadership is aware of the need to support these situations and believes the most critical element is maintaining the flow of information and minimizing misunderstandings. They further recognize that too much unsolicited help may become interfering; too little may lead to the perception of being non-responsive. Involvement in these international cooperative programs can be a delicate matter and apparently requires members to have the knowledge to take action independently or know where to get it. Hence, their task of promoting cooperation between nations begins with seeking cooperation within their functional community.

B. BACKGROUND

In February 2007, the Office of the Chief of Naval Operations (OPNAV) began to take steps to address the issue of cooperation within the Navy's SCC. The Director, Warfare Integration / Senior National Representative (SNR) (OPNAV/N8F), Mr. Eugene Sullivan, partnered with the Navy International Programs Office, the Space and Naval Warfare Systems Center in San Diego (SSC-SD), and the Naval Postgraduate School (NPS) to launch the International Bench. His intent was to improve cooperation by focusing on problem solving, issue resolution, learning, and collaboration across the Navy's SCC. Under his direction, SSC-SD began the effort by developing a pilot web-

based application, International Bench, with iterative improvements continuing. Their objective was to establish a collaborative environment in which to share information relevant to security cooperation community processes (SSC-SD, 2007).

In July 2007, NPS was asked by the SNR to provide research assistance for the International Bench project. Their objective was to evaluate the pilot project and recommend improvements focused on technological considerations. Missing was consideration for the social elements – interaction, learning, roles and responsibilities, and structure – that was outside the scope of the request. Dr. Bordetsky, Director of the Center for Network Innovation and Experimentation (CENETIX) assembled a project team consisting of four students enrolled in Information Science Course 4188 Collaborative Technologies. The project team consisted of Major Joseph Delaney, USMC, Major Guillermo Palos, USAF, Captain Rich Garcia, USMC, and Lieutenant Rob Biggs, USN. The project team exceeded the course requirements in order to incorporate these critical social elements. Major Palos was the first to provide a more in-depth continuation of that work, specifically addressing the socio-technical design not covered in the student project, in his Naval Postgraduate School Thesis: *Communities of Practice: Towards Cultivating and Leveraging Knowledge in the Military* (Palos, 2007). Whereas Major Palos' approach is knowledge focused; this thesis provides a continuation of that work with emphasis on the collaborative network. A major discovery made by the project team was that the characteristics of the International Bench – distributed community, overcoming challenges with time and place, desire for member interaction and information and knowledge sharing – fit well within the boundaries of what could be addressed by a Community of Practice. This discovery formed the basis for Major Palos' thesis as well as the recommendations made in this thesis.

The intent of the International Bench project team was to provide the Navy SNR with considerations for directing a new community toward a vision based on principles for long-term sustainability and growth that would enhance current and future work. Aspects of the student project are reiterated in their entirety throughout this analysis to maintain the integrity of the original analysis, though facts, figures, diagrams, and data have been updated to reflect the current status of International Bench where appropriate.

While this author feels that it is important to articulate the analysis criteria that went into the original student project, in-depth discussions regarding the importance of the actual criteria are not provided due to the scope of this thesis. Appropriate references have been provided which would allow readers to gain a deeper understanding into the areas used for analysis.

C. ANALYSIS CRITERIA

The analysis done on International Bench covered military decision support models, multi-participant topologies, communication modes, decision support roles, a review of current collaborative technologies, a comparison with a current collaborative exercise, and the results of interviews conducted on a sample of the Navy's SCC. This analysis allowed for an understanding of the current position of the International Bench and enabled sound recommendations to be made for the future of International Bench.

1. Military Decision Support System Models

In discussing the collaborative technology employed by the International Bench, the product currently in place has to be considered, as well as the product that is expected from the design end state. In its current state, the International Bench is a website that that serves as an e-mail connector to members of the SCC. It does not meet the vision of the end state to fulfill member's desires for interaction and information and knowledge sharing. To completely fit into a military decision support system model, International Bench will need to evolve to placing more emphasis on the collaborative process of the community and less emphasis on the technology utilized to maintain the connections. Because in it's current state the International Bench did not seamlessly fit in to a military decision support model, the focus was on what the International Bench stakeholders had as their vision for a model and potential usage. The model put forth by Simon in Figure 1 (Simon, 1979), emphasizing intelligence, design and choice, while logical, did not fit the current system in place by the SNR nor did it tend to describe how the intended users would interact with the system.

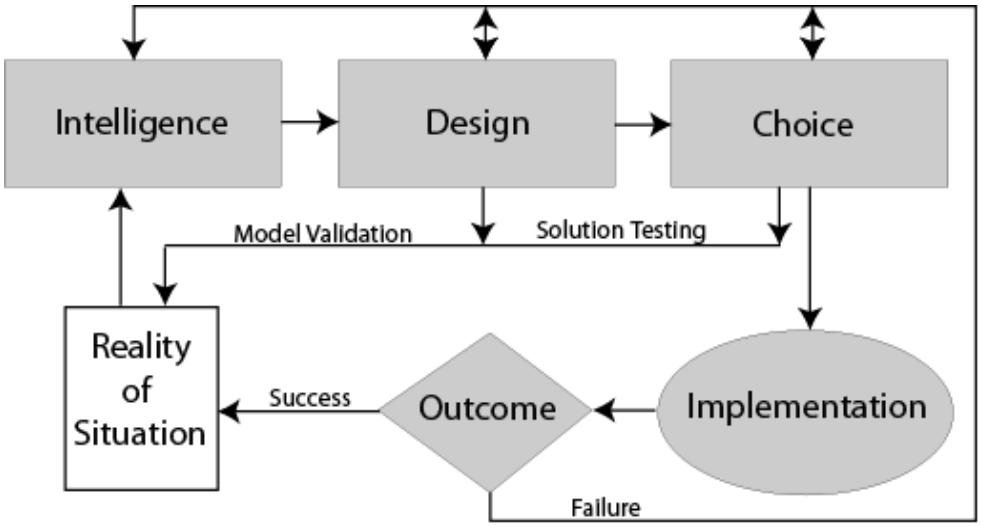

Figure 1. Simon's Decision Support Model. (From: Coram, 2002)

Specifically, the actual use of the collaborative process desired in the decision making cycle is only implicit and requires visualization (Bordetsky et al., 2007). Boyd's Observe, Orientate, Decide, Act (OODA) loop, shown in Figure 2, (Hammond, 2001; Coram, 2002) was perhaps a slightly better fit in that there is a shared stress on the cognitive processes of decision making.

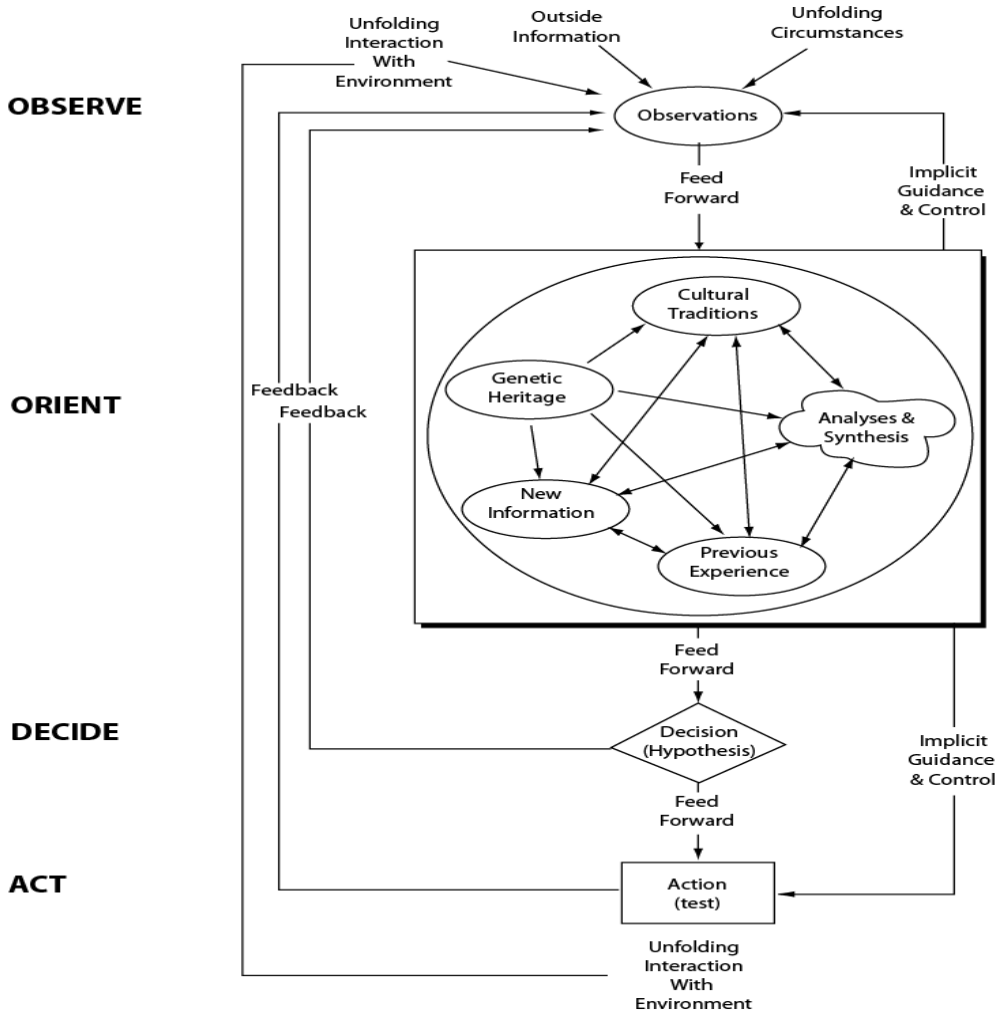

Figure 2. Boyd's Observe, Orientate, Decide, and Act (OODA) Loop Model cited in Information Science Course 4188 Collaborative Technologies (From: Bordetsky, 2007)

This stress on decision making was the impetus for creating the International Bench following a recognized need for quality improvement in the SNR communication system. The best fit of the major military decision support models was the Albert-Hayes Collaborative C2 model shown in Figure 3 (Alberts et al., 2006).

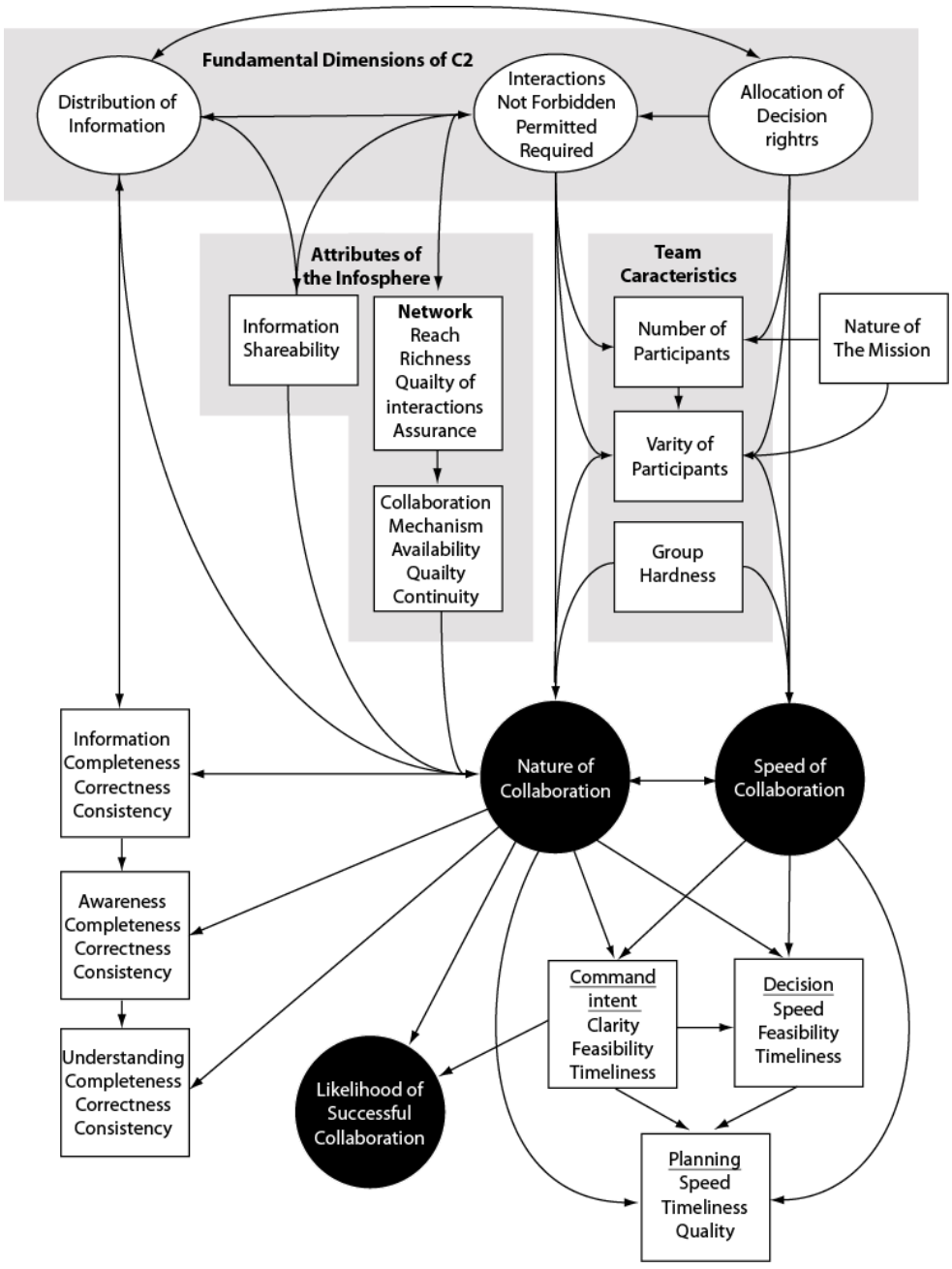

Figure 3. Collaboration Significant Influences. (From: Alberts et al., 2006)

This model emphasized information as a resource and the value of information towards decision making in general. Although this does not fit the current state of International Bench, it aligns with the stated vision and purpose as stated by the SNR.

Not explicitly a decision support model, the Alberts-Hayes version is more of an organization evolution model. This also aligned closely with the SNR design of having regions and sub-regions of communities of interest.

2. Military Participant Topology

The SNR team did not have a preference in mind for a multi-participant topology. Conventionally, a topology would consist of groups, teams or committees that would define the actual structure as shown in Figure 4. A group has multiple decision makers with complete interaction, a team has a single decision maker with no participant interaction, and a committee has a single decision maker with complete participant interaction.

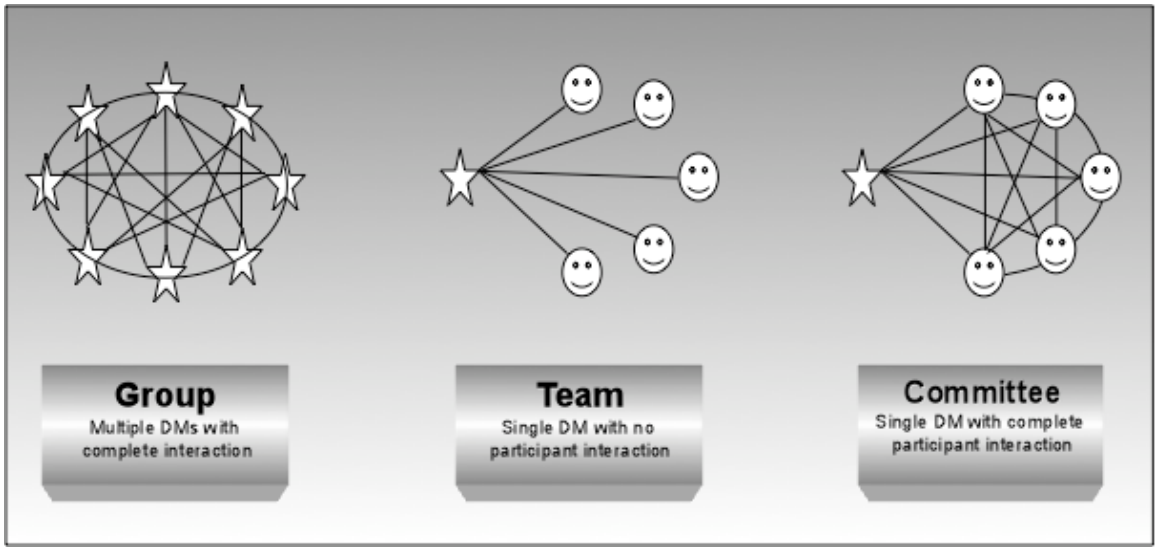

Figure 4. Basic Multi-Participant Decision-making Structures (From: Bordetsky, 2007)

Based on the stated objectives from SNR, it was possible that a group topology pattern would emerge, as decision makers would have complete interaction with all nodes of the network. In this scenario multiple decision makers are communicating and coordinating with their counterparts. Perhaps equally likely is a team topology in which a single decision maker was participating with other nodes of information but these nodes

were not in contact with each other. Based on the tools available and intended for inclusion, a committee topology was the probable outcome. It was highly feasible to envision a single decision maker requesting information, or submitting information for that matter, to participating nodes (i.e., other attaches or regional counterparts) with these nodes having complete interaction with each other. Realistically, the topology question is a matter of perspective. It might appear to the single decision maker in one topology that they are participating in a committee structure when in fact the macro view of the topology is group.

3. Communication Mode

Two primary modes of communications exist between collaboration tools. These are commonly referred to as client-server and peer-to-peer (P2P). Although P2P communication is a valid means of collaboration, the vision established for International Bench, which involves a group type structure such as a community of practice, would quickly surpass the capabilities of P2P communications. Beyond P2P, three types of architectures exist within computer models that relate to the client-server interaction referred to as Tier 1, 2, and 3 architectures. Briefly explained, Tier 1 architecture is a standalone application architecture where all processes are performed in a single program. Tier 2 architectures consist of a client and data server model where the server may contain a database and responds to queries submitted by an application on a client computer. The data requested is returned to the client computer where the computing is done. Tier 3 architectures are similar to Tier 2 but contain an additional application on the server where data processing is done prior to the data being returned to the client. This eliminates the overhead of transferring the entire record set of requested information to the client for processing and provides only specific answers to the query. The current model of International Bench was operating as a Tier 2 application. While a Tier 2 worked for the current model of International Bench, a Tier 3 would be preferred. Tier 3 is the preferred networking model and properly positions International Bench for future growth and implementation of collaborative technologies such as file sharing, discussion posts, threads, and additional applications that will result in queries and collaborative

communication. This is critical because of the vision established that led to the creation of International Bench. Tier 3 is the architecture that enables developers to implement tools that could potentially take advantage of emerging collaborating technologies.

4. Decision Support Roles

Prior to initiating this project, OPNAV/N8F had not considered the people element in the development process. Needless to say, the focus had been on developing a technology platform to enable the daily security activities of members of the SCC. Roles and relationships were an afterthought that was first addressed in the initial analysis. In this case, it was unclear of the ultimate roles that should be enabled by the fully operational International Bench application. Based on interviews with stakeholders, the following was the assessment of the decision support roles that could surface:

a. Keepers

Keepers are characterized by activities related to content management (i.e., control of access to shared data, time stamping, and versioning) (Bordetsky, 2007). At the time of the analysis there were no plans for the pilot project to incorporate data sharing or a content database. This functionality was beyond the current scope of the project. OPNAV/N8F, however, did foresee a future iteration of the portal to include this capability.

b. Coordinator

Coordinator is characterized by the activities related to workflow management, meeting coordination, and life cycle management (Bordetsky, 2007). This role was unlikely to be used for the same reasons for not using Keepers. The functionality was not a requirement at the present time. The stakeholders did not identify this functionality as a requirement in the long-term. However, future iterations may present the value of including additional collaboration tools that would drive the need for this role.

c. Communicators

Communicators are characterized by the activities related to enabling communication between members (Bordetsky, 2007). In this case, the pilot project had implemented a primitive fulfillment of this role. It provided members the ability to connect with each other through email lists and yellow-pages of subject matter interest. Future iteration may expand upon this with greater visibility to the value of communications between members. Since the SNR had yet to understand the importance of roles in a collaborative environment, the development of this role as a human activity may be hindered and left to automation.

5. Current Collaborative Technologies

As mentioned in the introduction, advances in collaborative capabilities demonstrated in current collaboration technologies offered significant insight towards defining a vision and future capability for International Bench. Hence, a review was conducted that included four tools, based primarily on experience and the availability of software (Microsoft Groove, Video Conferencing, Jabber, and Instant Messaging). The review revealed that all the applications had beneficial tools for the International Bench. Considering the highlights of each tool, Groove was the only one that would not be appropriate for this effort, due to its P2P architecture. For International Bench to be successful, the system would require a Client-Server architecture. Consideration was also given to a Service Oriented Architecture (SOA). It was initially believed that a portal based application would be most appropriate for the SCC. Since the user is only required to have a browser to access such an application, the usability is enhanced. A portal application that takes advantage of portlets, web services and an object-relational database, similar to Oracle Application Server (Oracle Collaboration Suite), seemed to be the most appropriate implementation. As shown in the summary of this chapter, the use of a SOA was abandoned. At the time of analysis, the pilot project was minimally a client-server start-up. A more flexible, composable, and secure system would be attractive to users. Chat, instant messenger, audio, Yellow-Pages, a Wiki, and workspaces are all capabilities that could prove to be beneficial for this community.

Such a deviation, however, from the current path of the pilot project might require a complete re-work and therefore may be unappealing. On the other hand, using Oracle Application Server has the capability of working with other applications. They could continue the current pilot project and add web services and portlets to the current design that could include additional tools such as instant messaging, web mail, document archive, Yellow-Pages and more.

6. Current Collaboration Exercise

In order to establish a basis for the development of the International Bench, a brief analysis of a collaboration exercise was conducted. The goal of this analysis was to explore the records of team collaborative tools usage and the event logs captured during the selected experiment and characterize the collaborative technology usage pattern in terms of frequency and timeline for using major collaborative technology building blocks (i.e., file sharing, white board, application sharing, chat, and audio/video communications).

The experiment analyzed was the Tactical Applications for Collaboration in FIRE (TACFIRE) Trident Warrior '07. During the TACFIRE exercise many collaboration tools were used and reported on. Although the TACFIRE exercise was a scenario based on Maritime Domain Awareness, with the primary operational focus being Humanitarian Assistance/Disaster Relief operations, there were many aspects of the exercise that helped provide understanding towards the capability of the collaboration tools used. By gaining a better understanding of the tools' capabilities, recommendations could then be made on the appropriate tools to be used in the International Bench. This was further enhanced by the fact that the analysis assessed the viability of the TACFIRE web services design. There was a great opportunity to use the technology demonstrated in the experiment for the development and operation of the International Bench; however, the International Bench development would require a significant amount of architecture development in order to make it a viable solution for the users. The TACFIRE experiment served as a means to stress test the configuration through streaming media and services intensive with messaging and media management. Important to the development of the

International Bench, is the fact that primary services were operational and all services were fully encrypted. As a side note, International Bench is for a much longer and slower time cycle than tactical level tools.

7. Interview Results

Beyond the analysis conducted from project inception, the need was determined to conduct one-on-one interviews with key personnel who would benefit from International Bench who were also actively engaged in fulfilling the roles and responsibilities outlined for the SCC in the introduction of this chapter. There were 8 interviews conducted with the purpose of drawing candid and insightful responses toward developing a conceptual design of the International Bench. The stance that was taken was from the prospective of outsiders looking in (not security cooperation experts). The responses were then coalesced together making generalizations. Therefore, the analysis does not quote any interviewees or attribute comments to a specific individual but instead draws conclusions based on the answers as a group.

a. User Characteristics

Experience In Security Cooperation Community:

- 4 of 8 or 50% had 10 or more years experience in Security Cooperation Activities.
- 4 of 8 or 50% had less than 10 years experience.

Personal Assessment Of Your Level Of Expertise In Security Cooperation Activities (Extensive – Moderate - Little):

- 4 of 8 or 50% had a moderate level of understanding of the Security Cooperation Community
- 3 of 8 or 37% had an extensive understanding.

Personal Assessment of your ability as a computer user/operator (High - Average - Low):

- 7 of 8 or 88% had average computer skills. (People tend to incorrectly assess themselves, though it was still important to capture how they felt about their abilities).

b. What Should International Bench Be to You?

In this section, respondents were asked to give their thoughts and ideas about what they felt they would like to see from the International Bench.

RESPONSES

- International Bench should be clear, easy to use, meaningful, and provide accesses to the right people all over the world all the time (24/7)
- International Bench should be a place to ask questions and get answers
- There are enough bosses as it is, International Bench should not become one more
- International Bench should help new people spin-up and accelerate learning
- Participation needs to be voluntary
- International Bench should allow every community member admission and permit them to decide how and how much to participate
- International Bench should promote collaboration between its members
- International Bench provides a website where people can gather and interact, access late breaking news, leadership messages, community activities (e.g. meetings or conferences), and find updates on extant projects or cases
- International Bench should be useful to support what is being done

c. Potential Usage

In this section, the focus was placed on determining how potential users would use International Bench. The interviewees were asked to respond to how they felt about three suggested usages consistent with the uses that the developers envisioned.

a. A virtual gathering place where members practicing security cooperation activities connect to share and learn from one another by sharing information, problems, experiences, insights, templates, tools, and best practices

b. An environment with no boss, no deadlines, and no commitments. An atmosphere that would foster free flowing of ideas and information with out deadlines or obligation

c. A place where the goal would be to promote learning through interaction toward job performance

RESPONSES

On average, 100% of all respondents felt that (a) was a good idea of what International Bench should be. Seventy-five percent felt that (c) was not a realistic idea and should be re-considered before trying to create that type of place. One-hundred percent of all respondents felt that (c) was a good idea. The following were some general comments that were made in addition to the specific answers concerning (a), (b), and (c).

- The "gatherings" portion should be explained to users as not only being virtual, but also physical…through annual conferences and meetings, etc
- Did not like the title "International Bench." Gives a sense of "sitting on a bench"
- Liked the idea of developing a Community of Practice atmosphere
- Should start with the Navy and then definitely expand it to the other Services for deeper insight
- Thought International Bench could address the perceived gap: People worried about doing the right things on a day-to-day basis

d. Usage Indicators

In this section the focus was placed on determining how potential users would encounter a situation that would require the need to use International Bench. This

was accomplished by asking them to evaluate their level of experience and compare that with the types of problems they could actually encounter and not necessarily have the experience level to solve the problem without help. The Security Cooperation arena (i.e., day-to-day work or surge issues) is developing or finding solutions to problems:

a. Easy – I have enough experience necessary to solve most problems associated with the job.

b. A Challenge – My level of experience is adequate to solve most problems but requires a reasonable level of work and tapping into my experience, further research, analysis, as well as interaction with others.

c. Difficult – My level of experience is not adequate to solve most problems and I seldom have solutions, and typically have to work harder than I should have to find solutions.

RESPONSES

On average, all respondents felt that due to their experience level that their ability to solve most problems encountered in their job was:

- Easy - About 52% of the time
- A Challenge – 34% of the time
- Difficult – 15% of the time

These results indicate that 49% of the time most users would require the International Bench to help them answer or solve most problems encountered in their jobs.

e. Building a Case for Membership

In this section respondents were asked how they thought users could be recruited or made aware of the International Bench.

In general all respondents felt:

- The site must have enough information pages to be useful to an assortment of users
- This site must be supported and pushed from the top down. If the leaders don't support it, the International bench will not be successful.
- International Bench should be perceived as the first stop for information.
- Build dependency. The use of Bulletin Boards would encourage users to post questions and seek help and as this occurs, users become more and more dependent on it.
- Set up the International Bench by regions.
- The site should have various levels of information available to users that will meet an array of interest (i.e., interesting new technology).
- It is very important to provide a directory (org charts, phone charts, location and mission descriptions) of all the organizations, offices and people in the SC community similar to something like yellow pages to include profiles with descriptions of what they do.
- "Seeing is believing" – Start small with a small core group who perhaps could participate in a "chat" room type of environment (discussion forum would be best) and show how this interaction leads to value. Make sure the results are marketed to the community; "spread the word."
- Why should people take time out of their busy schedule to participate in this? Show how it would benefit "Me"…this is the hard part.
- Design for "Sub-Communities". SC is massive, so breaking out into smaller facets is important; such as "Security Assistance."
- People should be able to get to quick answers.
- Recruitment must be wide. If leaders will be asked to push this site, putting their credibility on the line, the people touched need to find value in a short period of time. If not you are also liable to lose leaders that if they lose face in support this, they may decide not push it anymore.

f. Analysis of Responses / Surveys

The interviews proved to be the most valuable portion of the analysis and actual led to earlier analysis to be changed once additional user requirements and desires were identified. Overall, users are looking for a community that can provide an atmosphere where they can increase both their efficiency and effectiveness in their day-to-day responsibilities.

D. TECHNOLOGY

Once the fundamental functionalities and processes conforming to the vision for this strategy were clear, the next step was to determine what technology applications would best meet the need. To begin, varieties of extant technologies that are typically used by communities of practice (CoP) were evaluated. These technologies were characterized in relation to the time and space continuum illustrated in Figure 5. A CoP stands to benefit from technology if used to fill the gaps created by time and space. The continuum expresses the gaps that need to be resolved; such as a member being in a different place and a different time than the member he or she needs to interact with.

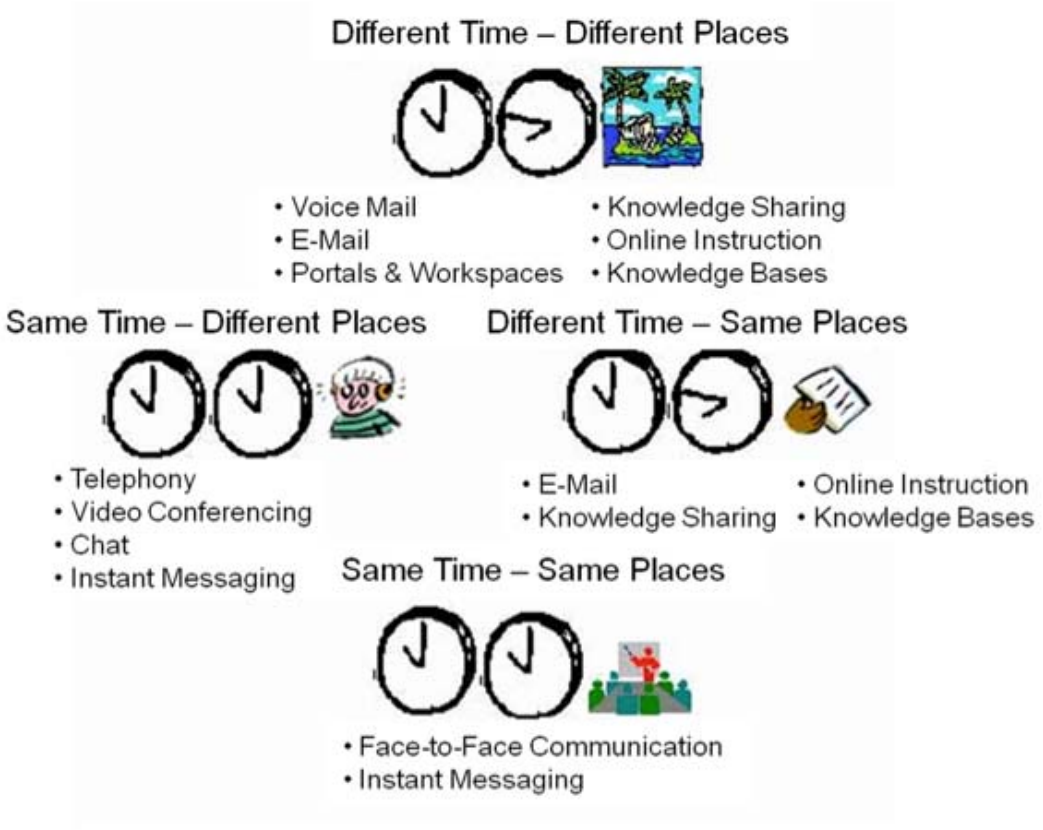

Figure 5. The Time and Place Continuum (After: Wenger, White, and Rowe, 2005).

Notice in Figure 5 the technologies were evaluated and situated under each time and space category to help determine which tools would best meet the needs for the International Bench. The technologies evaluated included:

1. Traditional Communication

Face-to-Face, Telephony, Voice Mail and Email: A technology solution to a CoP must start with the existing information and communications architecture. It is hard to find people that are not already well adapted to using face-to-face communication, telephones, and email. Therefore, working through established media is a good start to support a CoP. These traditional modes of communication provide the foundation towards resolving the time and space extension between people: same time/same place (face-to-face), same time/different place (telephony), different time/different place (voice mail, email), and different time/same place (email).

2. Peripheral Communication

Video conferencing, chat, and instant messaging: Some would consider these applications as traditional modes of communication due to their extended presence in social networking. In business, however, they tend to serve as a secondary means of communication behind traditional modes and are typically not used as part of daily work routines. These applications would benefit a CoP by supporting communication and addressing limitations with traditional communication. In particular, same time/different place (synchronous) communication is enhanced. Video, chat, and instant messaging provide the community additional features that support knowledge flow. Video adds a visual dimension that is useful for stimulating an added sense that is normally only captured during face-to-face communication. Chat and instant messaging supports enhanced group communication and normally includes features to save this synchronous communication for reuse or sharing.

3. Portals and Online Workspaces

Internet Website: A community needs to have a front door leading into a place to work, to meet, to collaborate and to learn. Portals and online workspaces provide the

CoP with a common environment accessible by all members any time and from any place. Having a common work environment also provides the community with an identity that represents the relationship between its members and their interest. They serve as a platform to launch the other applications described in this survey and also to link one activity with others. A well designed Internet website should have the capability to address each of the time and place gaps.

4. Information Sharing

Yellow Pages, Wikis, Blogs, Discussion Forums, Real Simple Syndication (RSS) and Frequently Asked Questions (FAQs): Information sharing applications represent the current revolution in the evolution of the Internet. Yellow Pages offer the CoP participant access to knowledge through knowledge maps and expertise profiles. Wiki applications allow any community member to edit community content anytime. Blogs and Discussion Forums allow CoPs to communicate asynchronously. These are seen as conversations that have focus and where all can participate. RSS and FAQs represent applications that offer additional means to find and receive information.

5. Online Instruction

eLearning: The flow of knowledge is important to a CoP. eLearning contributes to this by providing a cost efficient way of promoting knowledge flow in a more traditional manner. It has evolved from earlier versions (i.e., computer or web based training) where the technology was the central focus. Now, with eLearning the central focus is on the content. CoPs stand to benefit from this application by having an easily accessible learning platform that guides members to a focused learning context relevant to the community's theme.

6. Information Bases

Document Repositories: Finally, document repositories are an essential element in a knowledge management program. These applications contribute to a CoP by providing a place to instantiate information (i.e., written text, video and audio) into virtual warehouses for organization, formalization, and sharing of information. This

provides the community a means to reuse information toward supporting the flow of knowledge. Drawing from this inventory of technologies and using the time and place continuum to help assess their usefulness, the analysis showed the most fitting technologies to use for the International Bench were those that addressed gaps when "different time-different place" and "same time-different place" are issues as shown in Figure 6.

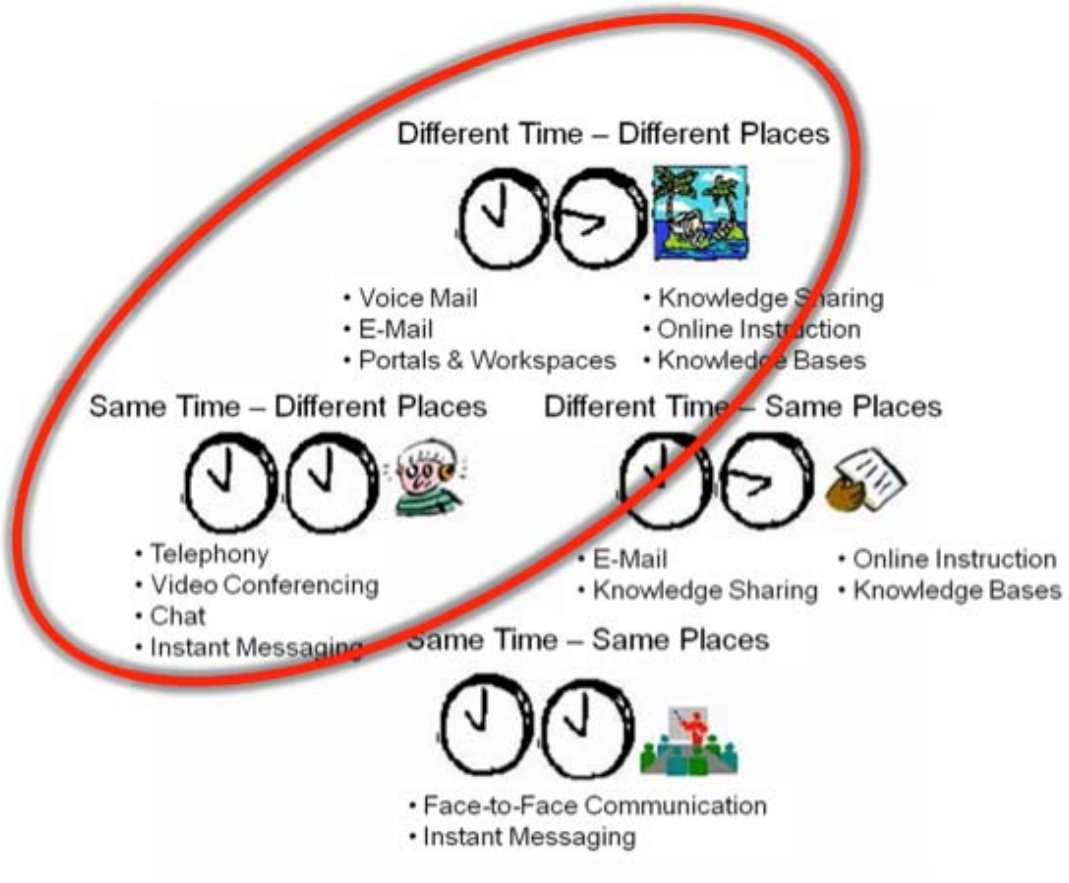

Figure 6. The Time and Place Continuum (After: Wenger, White, and Rowe, 2005).

Additionally, the technologies found to be the best fit for the International Bench were those that also best met the subsystem concept depicted in Figure 7.

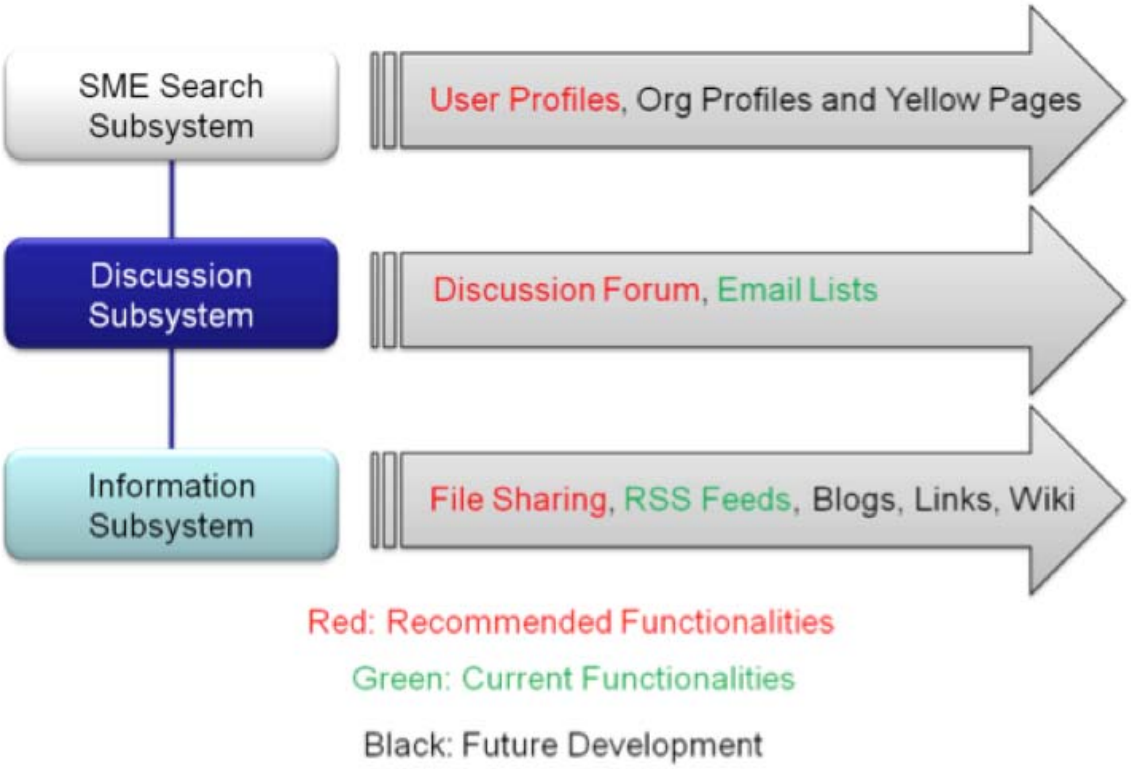

Figure 7. Summary of applications, by subsystem, for International Bench

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IV. MARITIME INTERDICTION OPERATIONS BENCH

A. INTRODUCTION

This section introduces the Maritime Interdiction Operations (MIO) Bench, a new initiative designed to provide a collaborative strategy for planners involved in MIO experiments under the cognizance of the Naval Postgraduate School (NPS) Center for Network Innovation and Experimentation (CENETIX). CENETIX provides deployable network integration and operating infrastructure for interdisciplinary studies of multiplatform tactical networks, Global Information Grid connectivity, collaborative technologies, situational awareness systems, multi-agent architectures, and management of sensor-unmanned vehicle decision maker self organizing environments. Although CENETIX has its beginnings, dating back to 2001, in unmanned aerial vehicles, it has evolved to a broader experimentation base encompassing innovative collaborative architectures. The primary experiments conducted under the cognizance of CENETIX are Tactical Network Topology (TNT) and MIO. The TNT and MIO experimentation series serve as a test bed platform for the United States Special Operations Command and other Department of Defense entities to test state of the art commercial-off-the-shelf and government-off-the-shelf technologies. Through the TNT and MIO experimentation platform, technologies are tested in hypothetical tactical scenarios and evaluated based on operational metrics. These experiments all support the overarching goal of CENETIX, to integrate unmanned air, ground, and underwater vehicles with computer equipped war fighters and unmanned sensor grids distributed across Internet protocol network centric systems (CENETIX, 2008). Experts who make up the network that support MIO include Lawrence Livermore National Lab (LLNL), Biometrics Fusion Center (BFC), Massachusetts Institute of Technology (MIT), Stanford University, University of California – Santa Barbara (UCSB), and U.S. and allied military agencies around the world.

B. BACKGROUND

By summer 2008, Dr. Alex Bordetsky, an NPS Professor in the Graduate School of Information Sciences and Director of CENETIX, recognized the unique and innate challenges facing the development of the International Bench. While the analysis of International Bench demonstrated its capabilities towards the management of communications with experts in geographically distributed collaborative networks, Dr. Bordetsky wanted a platform to conduct tests and experimentation without affecting the Navy's SCC. He orchestrated the establishment of a MIO Bench under the guidance of CENETIX. These actions and the author's previous involvement as part of the International Bench project team led to the development of this chapter appropriately titled Maritime Interdiction Operations Bench.

In the most recent MIO experiment conducted in September 2008 (MIO 08-4), the expert community strongly supported the exercise and provided valuable resources. The objective of MIO 08-4 was to continue to evaluate the use of networks, advanced sensors, and collaborative technology for rapid maritime interdiction operations. This included developing the capability to search for radiation sources and set up ship-to-ship and ship-to-shore communications while simultaneously maintaining network connectivity with all exercise participants. Overall, the exercise was designed to simulate the ability to maintain command and control while encountering a radiological threat in the Ports of New York and New Jersey (TNT MIO 08-4 After Action Report, 2008).

While the actual participants of each MIO change slightly, approximately 10% a year (Bordetsky, 2009), and the numbers of participants are continuing to grow, the analysis in this thesis examines a snapshot of the contributions of some of the experts and the subject matter of their communications. A more detailed description of the contribution of the MIO experts can be found in historical MIO documents (i.e., TNT MIO After Action Report 08-4) or in NPS Student Thesis "Exploring Data Sharing Between Geographically Distributed Mobile and Fixed Nodes Supporting Extended Maritime Interdiction Operations" (Mercado, 2008). Figure 8 gives a geographical overview of where the participants for MIO 08-4 existed, followed by descriptions of key participant organizations.

Figure 8. World Wide Marine Interdiction Operation Participant Geographical Location. (From: MIO 08-4 After Action Report, 2008)

1. Naval Postgraduate School

In MIO 08-4, NPS provided capabilities in the area of networking (i.e., ship-to-ship and ship-to-shore), collaborative technology, operations and command centers, virtual private networking reach back, unmanned vehicles, and biometrics. NPS provided a robust team of participants to support all locations involved in the exercise while maintaining cognizance over its conduct and execution (MIO 08-4, 2008).

2. Lawrence Livermore National Laboratories (LLNL)

LLNL provided radiation sources, radiation detection, radiation reach back, ultra-wide band communication, explosives detection, export control, and modeling expertise. The mission of LLNL is to advance and apply science and technology to:

- Ensure the safety, security, and reliability of the U.S. nuclear deterrent

- Reduce or counter threats to national and global security
- Enhance the energy and environmental security of the nation
- Strengthen the nation's economic competitiveness

LLNL employs teams of physicists, chemists, biologists, engineers and other researchers to collaborate together to achieve innovative and scientific breakthroughs to nationally important problems. The purpose of LLNL, with respect to the MIO, is to provide remote expert intelligence about the sensor data captured during the MIO and provide the tactical operations center with feedback and recommendations for further analysis. Recognized as an expert in their field, LLNL officials respond regularly when local Customs and Coast Guard officials at the San Fransico Airport and the Port of Oakland receive unusual alerts on the radiological pagers. Additionally, LLNL, works closely with the California Highway Patrol to develop additional detection technology to prevent smuggling of radiological material into the state (LLNL, 2009; Mercado, 2008).

3. Biometrics Fusion Center (BFC)

The Biometrics Fusion Center, located in Clarksburg, West Virginia, provides intelligence derived from collected biometric data. Established in December 2000, the BFC provides biometric repository support to the Department of Defense. Its core functions include establishing and maintaining an authoritative biometric data source in order to provide timely, accurate, and comprehensive feedback (WV Biometrics Initiative, 2009).

4. United States Coast Guard

The United States Coast Guard, as part of the Department of Homeland Security, operates the National Response Center (NRC). The NRC is the sole U.S. Government point of contact for reporting environmental spills, contamination, and pollution. The primary function of the NRC is to serve as the sole national point of contact for reporting all oil, chemical, radiological, biological, and etiological discharges into the environment in the United States and its territories. The NRC maintains agreements with a variety of

federal entities to make additional notifications regarding incidents meeting established trigger criteria. The NRC also takes Terrorist/Suspicious Activity Reports and Maritime Security Breach Reports (USEPA, 2009).

5. Federal and Local Law Enforcement Agencies

The Federal Bureau of Investigations (FBI) has a database called the Guardian Threat Tracking System, which holds information on maritime and other terrorist threats and suspicious incidents. Oakland, San Francisco, and Sacramento maritime interdiction forces collaborate with each other and with the Coast Guard to provide the manpower, intelligence reports, and interdiction tactics to further assist command and control elements in finding maritime terrorists or high value targets. Additionally, the Defense Threat Reduction Agency works to reduce the threat to the United States and its allies from nuclear, biological, chemical weapons, other special weapons, and conventional weapons, through the execution of technology security activities, cooperative threat reduction programs, arms control treaty monitoring and on-site inspections, force protection, nuclear, biological, chemical defenses, and counter-proliferation (Harahan & Bennett, 2002; Mercado, 2008).

6. Naval Research Laboratory (NRL)

The NRL provides Tactical Satellite capabilities to local and remote government agencies. During the MIO experiments, NRL provides imagery of Monterey bay and radiation spectrum files to LLNL (Mercado, 2008).

7. Maritime Intelligence Fusion Center (MIFC)

The role of MIFC is to provide maritime traffic information such as ships' registries, cargo and crew manifests, ports of call, and shipping schedules. This information is used to designate a vessel as suspect, locate it, make its interdiction possible, and confirm discrepancies onboard, such as fake documentation (Stavroulakis, 2006; Mercado, 2008).

8. United States Department of Energy

Under the U.S. Department of Energy, the National Nuclear Security Administration (NNSA) handles worldwide radiological accidents and incidents through various assets, one of which is the Radiological Assistance Program (RAP). RAP is one of NNSA's first responders for assessing situations to minimize hazards of a radiological emergency through assessment, area monitoring, air sampling, and exposure and contamination control. Able to arrive within four to six hours of notification of a radiological emergency, RAP personnel use state-of-the-art equipment to help identify or minimize radiological hazards (RAP, 2008; Mercado, 2008).

9. Coalition Partners

Coalition partners are involved in the experiments to bring in a geographically distributed node perspective in the MIO experiments conducted with operational conditions. Austria, Sweden, and Singapore have been greatly involved with the San Francisco MIO experiments conducted in collaboration with CENETIX, NRL, the Coast Guard, LLNL, BFC, MIFC, DTRA, and local maritime interdiction forces from San Francisco, Oakland, and Sacramento in order to better evaluate the geographically distributed collaboration of experts in the MIO network. Through their participation in the MIO experiments, a better commitment to understanding how international participants help to provide data necessary to evaluate a MIO situation involving terrorists, radiation materials, or WMDs (Mercado, 2008).

C. ANALYSIS CRITERIA

The analysis criteria used for International Bench covered military decision support models, multi-participant topologies, communication modes, decision support roles, and a review of current collaborative technologies. This analysis provided valuable data and allowed for the development of a frame of reference to use in the development of recommendations and a conceptual design for the MIO Bench. Although detailed background is not reiterated in its entirety, portions of the analysis are provided with the emphasis appropriately shifting from International Bench to MIO Bench.

1. Military Decision Support System Models

In discussing the collaborative technology employed by the MIO Bench, the product currently in place is identical to that of International Bench to include the physical layout of the website. This is primarily because the project is still in its infancy phase and has not undergone any additional development. Therefore, like International Bench, consideration must be given to what is expected from the design end state. At the current time, the best fit of the major military decision support models is the Alberts-Hayes Collaborative C2 model (Alberts et al., 2006). This model aligns closely with the inherent design of regions and sub-regions of MIO participants.

2. Military Participant Topology

Based on the current mode of collaboration for MIO planning, the interaction between all nodes would prove to be limited. Based on the objectives for MIO, a group topology pattern would prove to be beneficial, as experts would have complete interaction with all nodes of the network. In this scenario experts would collaborate with their counterparts on an ongoing basis. Currently, also similarly to International Bench and based on the tools available and intended for inclusion a committee topology was the probable outcome. It was highly feasible to envision a single expert requesting information, or submitting information for that matter with these nodes having complete interaction with each other. Figure 9 demonstrates one configuration of how the MIO participants were connected utilizing the multi-participant topology descriptions. In this figure, the smiley faces are the decision makers and/or contributors. The stars are the hubs and/or connectors. Numerous configurations take place depending on the make up of the network and the objectives of the MIO.

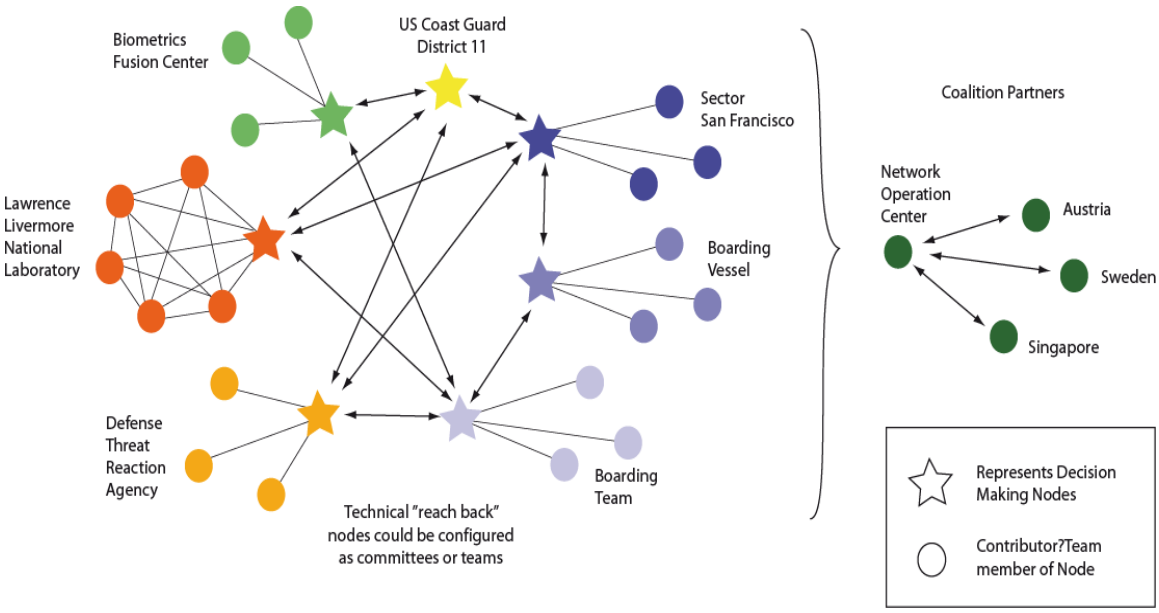

Figure 9. Marine Interdiction Operations 06-04. (From: Bordetsky, 2007)

Another way to view the MIO participant network and gain an appreciation for the evolution and growing scale of the MIO expert network is shown in Figure 10.

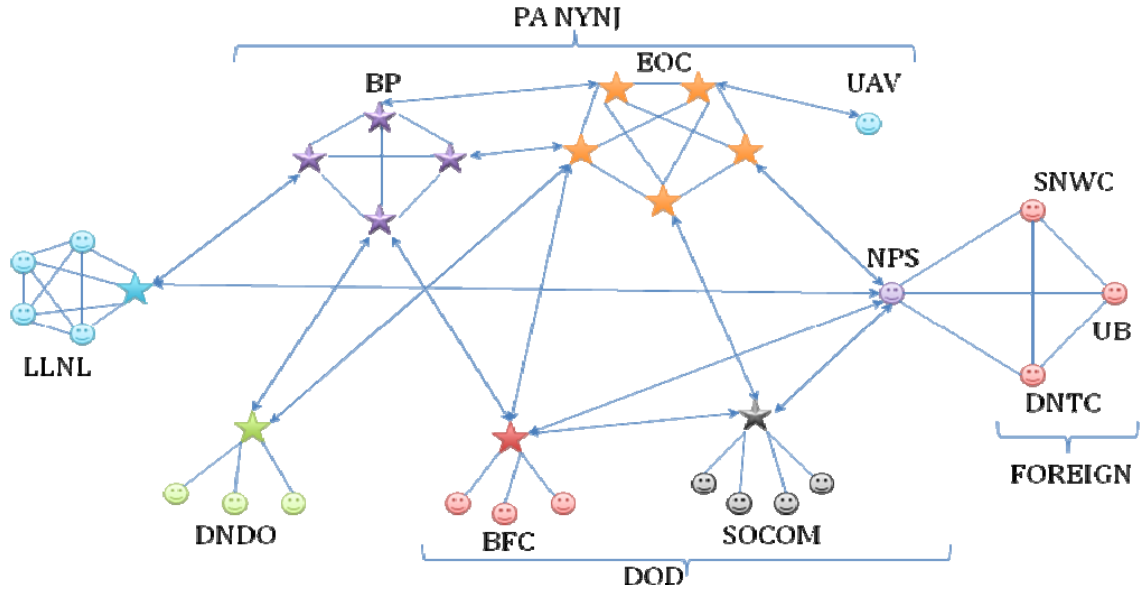

Figure 10. Teamwork Models in Marine Interdiction Operation Exercise. (After: Chen et al., 2009)

3. Communication Mode

The current mode of communication for the MIO planner's community is e-mail and teleconference. Although, during the exercise Microsoft's Groove is used, this does not assist in the planning process. Similarly to International Bench, the vision established for MIO Bench would quickly surpass the capabilities of P2P communications. The current model of MIO Bench is setup and operating under a Tier 2 application due to its duplication of International Bench. As analyzed in Chapter III, International Bench, a Tier 3 would be preferred and would properly position MIO Bench for future growth and implementation of collaborative technologies (i.e., file sharing, discussion posts, threads, and additional applications) that will result in queries and collaborative communication.

4. Decision Support Roles and Responsibilities

To his credit and due to his experience in the field of Information Science, the director of CENETIX, Dr. Bordetsky, had considered the people element in the development process for MIO collaboration and subsequently the MIO Bench development. Although the focus for International Bench had been on developing a technology platform to enable performance, roles and relationships for MIO were already in place and could be easily integrated once a technological solution for MIO Bench was determined. Based on MIO 08-4, the following was the assessment of the Decision Support roles and responsibilities that were used.

- Experiment Design, Coordination, and Control
- Coordination Support
- Port of New York / Port of New Jersey Response Team
- Boarding Team and Surface Assets
- Operations Centers
- Nuclear and Radiation Sensors and Remote Experts
- Biometrics Identification Sensors and Remote Experts
- Networking Infrastructure
- Collaborative Technology and Situational Awareness Environment

- Overseas Early Warning Sites
- Department of Defense Response Sites

Aside from these roles currently used in MIO, the following is provided from the International Bench analysis as a reminder of the overarching goals necessary to enable success in this distributed collaborative network.

- Keepers - characterized by activities related to limited content management (control of access to shared data, time stamping, versioning).
- Coordinators - characterized by the activities related to workflow management, meeting coordination, and life cycle management.
- Communicators - characterized by the activities related to enabling communication between members.

5. Current Collaborative Technologies

Benefiting from the review of current collaborative technologies preformed during the analysis on International Bench, the analysis on MIO Bench immediately focused on Microsoft Groove. The initial analysis concurred with the International Bench analysis and found that Groove was not appropriate for this effort, due to its peer-to-peer architecture. For MIO Bench to be successful, the system would require a Client-Server architecture. Because the MIO requires extensive planning, a more flexible, composable, and secure system would be attractive to users that would offer chat, IM, Audio, Yellow-Pages, a Wiki and workspaces. Because little has been done to date on the actual development of MIO Bench, this deviation would require little rework.

D. TECHNOLOGY

The MIO community of experts is constantly faced with technology challenges they must find ways to overcome. The criteria used to evaluate a solution for MIO Bench closely mirrors the ones used for International Bench. These include the following that were described in the International Bench analysis in detail:

- Traditional Communication (Face-to-Face, Telephony, Voice Mail and Email)
- Peripheral Communication (Video Conferencing, Chat, Instant Messaging)
- Portals and Online Workspaces (Internet Website)

- Information Sharing (Yellow Pages, Wiki, Blogs, Discussion Forums, Real Simple Syndication, and Frequently Asked Questions)
- Online Instruction (eLearning)
- Information Bases (Document Repositories)

Drawing from this inventory of technologies and using the time and space continuum to help assess their usefulness, the most fitting technologies to use for the MIO Bench are those that address gaps when "different time-different place" and "same time-different place" are an issue as shown in Figure 11.

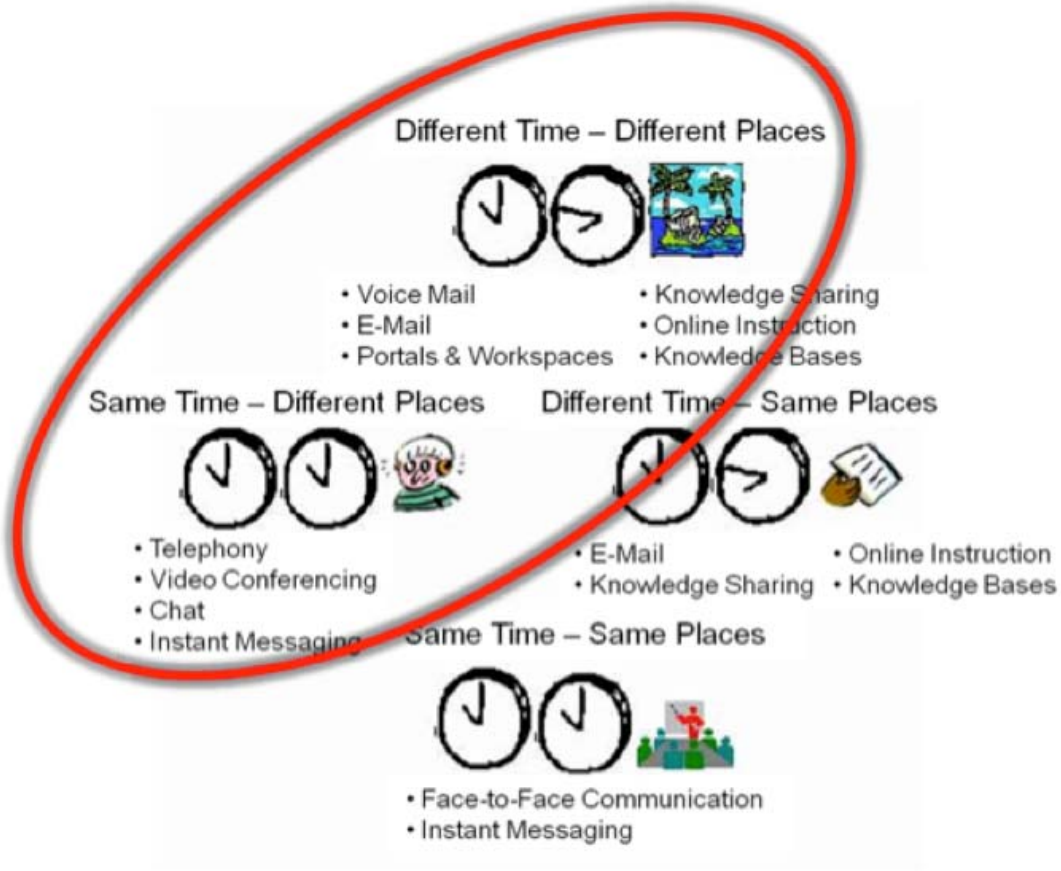

Figure 11. The Time and Place Continuum (After: Wenger, White, and Rowe, 2005).

E. FACTORS CONSIDERED IN THE CONCEPTUAL DESIGN

An enterprise that seeks to attract the voluntary participation of people should pay attention to those things that motivate, fit, satisfy and discourage them. Consider the substantial professional, social, and functional diversity of the MIO planner's community. It spans across academic, government, and civilian agencies worldwide. It is physically distributed across allied and friendly nations. It serves under multiple functional stovepipes and chains of command. Indeed, it would be a difficult matter to develop a community wide strategy that would fit like a glove for every expert of this community. Therefore, the design approach this thesis took was to address only a few fundamental elements believed to be critical considerations. Those elements included formal social relationships and unifying characteristics, requirements, and vision and purpose. Development of a system based on these three considerations perhaps constructs a broad net that may not capture all the wants, needs and desires, but it provides for a good start that could be iteratively improved throughout its lifecycle.

1. Formal Social Relationships and Unifying Characteristics

As discussed, the MIO planner's community is widely distributed across space, time, organizations, and chains of command. This makes for a challenge to attempt to design a community wide strategy. Therefore, this analysis first looked at evaluating the type of formal relationships and unifying characteristics that brought the community together. Consider the many types of formal constructions of addressing group relationships. Nickols (2006) developed a matrix, shown in Table 1, to help understand the distinctions between the types of formal groups. Each type is assessed based on six dimensions that Nickols believes to be defining characteristics in such a comparison. Using this as a guide, a Community of Practice (CoP) would best characterize the MIO community considering the desires of its expert planners to develop expertise, their membership designed by invitation, their authority being based on their expertise, and their unique identities which forms their cohesive network. Further conceptual development would consider design decisions that are best for this type of group.

	Purpose	Membership	Authority	Allegiance	Cohesion	Duration
Organizational Unit	Results from resources	Assigned	Positional	Upward	Leadership & Relationships	Ongoing - Until Reorganized
Operating Team	Ongoing tasks	Assigned	Positional	Upward	Task Dependencies	Ongoing - Until Reorganized
Task Force & Project Team	Time-bound tasks/results	Assigned	Positional	Upward	Leadership & Relationships	Inception to Completion
Faux Team	Appearances	Assigned	Non-existent	Fragmented or Non-Existent	Management Pressure	Until Disbanded or Fades Away
Social Network	Information Sharing	Invitation & Approach	Information	Norms	Value of the Information	Ongoing - Until It Dies Out
Community of Interest	Stay Abreast	Invitation & Approach	Knowledge	Peers	Level of Interest	Ongoing - Until It Dies Out
Community of Practice	Develop Expertise	Invitation & Approach	Expertise	Practice	Identity	Ongoing - Until It Dies Out

Table 1. Types of formal social relationships (From: Nickols, 2006)

For further clarity, a Community of Practice is:

> …a group of people mutually interacting and communicating to learn from each other. A common practice, interest, issue or problem creates an informal bond that is fed by a desire or need to share and learn toward adding to individual knowledge and improving the overall practice.
>
> Members – face-to-face or virtually – share information and what they know, explore new ideas and help each other solve problems. Members get involved voluntarily, do not recognize a community hierarchy or authority, and are not bound to deadlines or commitments. Organizations benefit when they cultivate and support the community.
>
> Ultimately, the flow of relevant knowledge sustains the existence of a community of practice. (Palos, 2007)

2. Requirements

Quality attributes, such as performance, reliability or maintainability, are examples of those software constraints that influence the architecture. These are typically addressed throughout the development process. One quality attribute, which is best to pin down before beginning work, is the functional requirements for the system. This allows for the communication of what elements are needed, at the most basic levels,

to the software developers. By doing so, the development process is given good traction by lowering the risk of the end product not meeting user needs. Based on this analysis, the following requirements represent the basic and foundational considerations that should be addressed in the design:

- Improve the sharing of information and leveraging of knowledge across a distributed community.
- User know-how and IT infrastructure is uncertain. Therefore, a browser-based application is needed.
- Size of user population is uncertain with potential for growth. Therefore, planning for growth is required.
- File and information sharing is needed
- Asynchronous communication is needed (i.e., messaging)
- Control, access and sensitivity are a major issue. Access to application must be controlled. No classified information will be discussed, but data security is requested.

3. Vision and Purpose

Vision and purpose are powerful vehicles that usher energy, focus and effort in a specific direction. John Kotter (1995), in his seminal work on leading organizational change, suggests that: leaders must create a vision to help direct effort, communicate that vision to help promote buy-in, and empower others to act on that vision. It is recommended that the purpose of MIO Bench be formalized to set the effort in a positive and clearly focused direction. The MIO Bench is a virtual gathering place where experts involved in the planning of MIO experiments can share and learn from one another by sharing information, problems, experiences, insights, templates, tools and best practices.

F. CONCEPT APPROACH

Considering the previous discussion on those factors evaluated as key in this thesis, the next focus was to develop an appropriate perspective. The perspective taken influences design decisions; therefore, should be correctly aligned with those things discussed previously. Specifically, when addressing a CoP, one can adopt one of two contemporary streams of thought: an information-focused or a knowledge-focused

perspective. Table 2 summarizes these divergent streams of thought. Sveiby (2001) explains that those who take on a knowledge-focused perspective believe that the value in knowledge comes out when its many forms are leveraged. Those with an information-focus believe the value in knowledge comes out when it is codified into information. Relative to this effort, if the team takes on an information-focused approach, attention would be placed on developing a strategy for managing and sharing information. In contrast, by adopting a knowledge-focused perspective, the team would place greater importance on seeking to connect people to promote people to people interactions, thereby developing a better strategy for managing communications with experts. The former seeks to find ways to connect people to information; the later seeks ways to connect people to people. Therefore, considering the vision and purpose for the MIO Bench, the best appropriate perspective is the knowledge-focused approach.

Stream	Goal	Origin	Description
Knowledge-Focused	**Seeks Effectiveness**	**Japanese/ Swedish**	The value in knowledge comes out when its many forms are leveraged. The focus is on people, learning and managing competencies individually. A knowledge-focused KM strategy tends to invest in people, training, trust, management education and to make the work environment more attractive and conducive for communication. The expected outcome is creativity, innovation and knowledge creation.
Information-Focused	**Seeks Efficiencies**	**American**	The value in knowledge comes out when it is codified in the form of information. The focus is on information management systems. Knowledge is seen as an object that can be identified and handled in information systems. An information-focused strategy tends to invest in computer systems, databases search engines, document handling, etc. The expected outcome is accessibility to information, avoiding duplication of effort, and timeliness.

Table 2. Streams of thought on Knowledge Management (After: Sveiby, 2001)

The knowledge-focused approach seeks to find the most effective, versus efficient, ways to promote interaction. Figure 12, presented below, assessed the methods that people learn in a work environment. This referenced continuum illustrates a spectrum of manners for which people learn toward a capacity to act or perform. On one end are those methods that achieve learning by doing. On the other end are those manners that promote learning by interacting. These tools represent an inventory of opportunities that a manager or designer should consider using when trying to harness how knowledge is gained in the work environment. For the development of this strategy, since the purpose is to promote interaction and subsequently learning, the focus is on the tools encircled at the bottom half of the continuum: interaction, discussion, consideration, conversation, storytelling, mentoring, observation, education or reflection. The thought was to evaluate different technologies that would enable the use of these tools to help enable learning and the subsequent management of communications with experts in geographically distributed collaborative networks.

Figure 12. Spectrum of tools for learning (From: Palos, 2007)

G. THE CONCEPTUAL DESIGN

Drawing again from the vision for this system and now from the approach just discussed, the analysis considered the basic, but critical, functionalities that best meets the spirit of what has been discussed. Therefore, an attempt to build the reference conceptual architecture that best met what is envisioned to be the imperative for this strategy is provided with an initial discussion on the role of technology. Technology, in general, is important for a CoP, but in a supportive role. The knowledge-based view of knowledge management sees technology as important, but in a supportive role. Nissen (2006) reminds us that people, not technology, are central to the flow of knowledge. However information technology does have a place since it plays a supportive role in organization work routines. Technology has actually enabled CoPs to flourish due to their capability to support knowledge flow across an extension of time and space. Therefore, it can provide a substantial boost in workflow and knowledge flow. Because of the distributed nature of the MIO planner's community, it is conceivable that it will be entirely a virtual community (little to no face-to-face interactions). The implication of this is that the community must fully rely on technology to enable interactions between members. Therefore, the role of technology as an enabler here is critical. Drawing from the suggested purpose and vision for this CoP, consideration should be made for the following three capabilities illustrated in Figure 13.

1. Subject Matter Expert (SME) Search

The purpose of this sub-function is to provide a means for a member with a problem, issue, or question to find another user with potential to provide insight, experience, or suggestions. The assumption is that the appropriate expert will be located to interact with them and subsequently lean toward taking action. If the member is unable to find an expert, a facilitator or another expert acts as a "connector" for the needing member and someone with the potential knowledge.

2. Discussion Forum

The purpose of this sub-function is to provide a means for a member with a problem, issue, or question to find a discussion thread that may provide information they can learn from and subsequently resolve their issue from what they learned. It also allows them to start new discussions to solicit responses and make contributions.

3. Information

The purpose of this sub-function is to provide a means for an expert with a problem, issue, or question to find relevant information for resolving their issue.

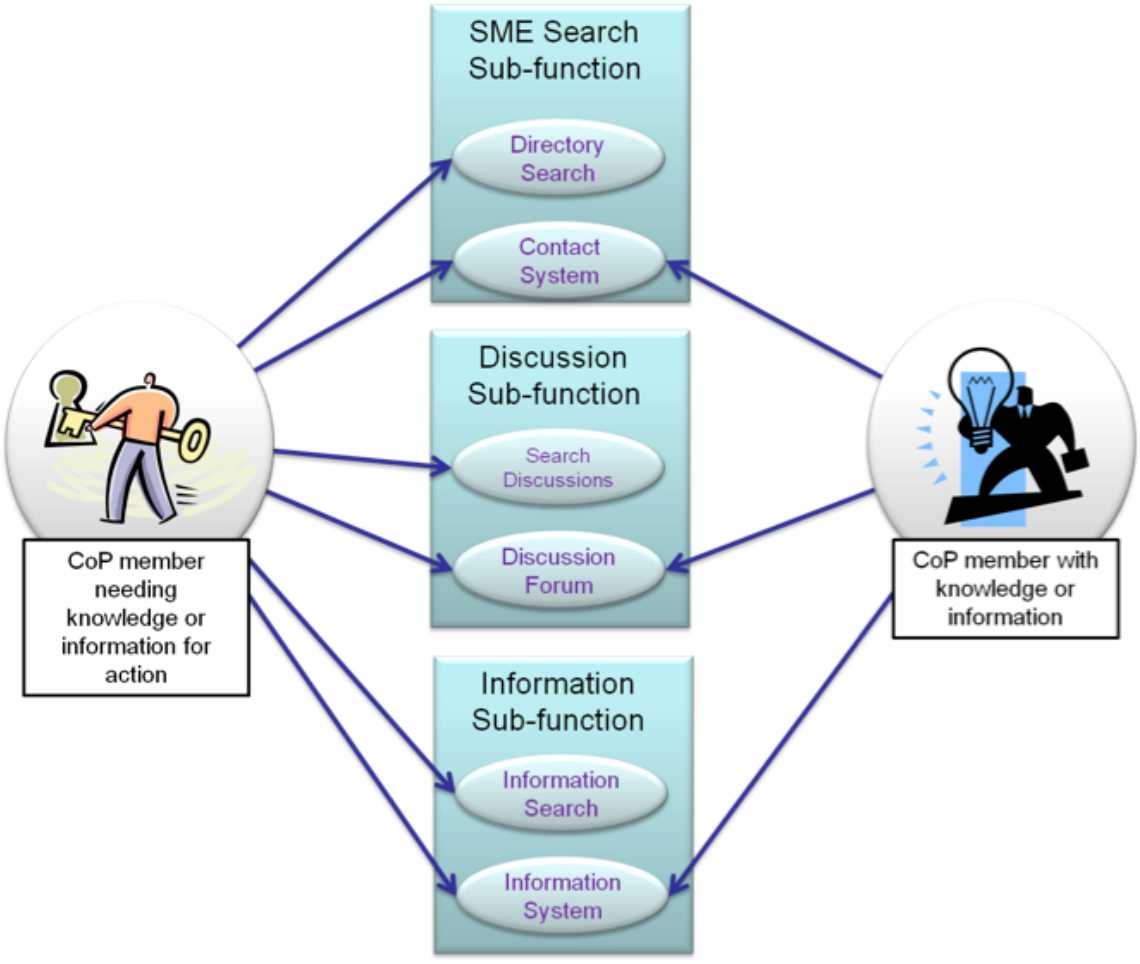

Figure 13. Maritime Interdiction Operations Bench Functionality

Further, the three basic paths, depicted in Figure 14, would be available to the member needing to learn: they can search for an SME and contact them through any available medium (e.g., email or phone), find an existing discussion or create a new one, or search for information.

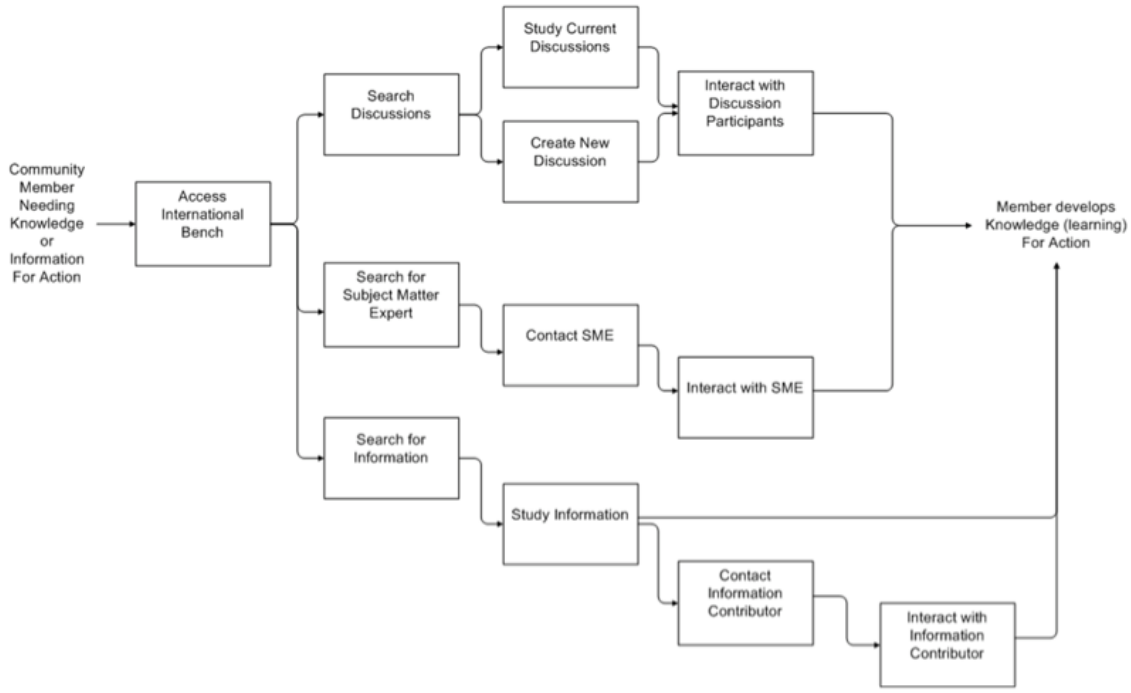

Figure 14. Learning process enabled by the MIO Bench

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V. CONCLUSION AND FUTURE WORK

The International Bench presented a ripe testing ground for the diversity of collaboration strategies available for consideration in managing communications with experts in geographically distributed collaborative networks. The analysis assessed this distributed community of experts to be in need of much more than the current pilot project had to offer. The client-server Tier 2 model employed was a good start at that time. In conclusion, the following highlights are presented:

- The International Bench is intended to fill the need for information and knowledge flows between the military and civilian members of the U.S. government participating in a geographically distributed network
- The information technology capability, know-how and infrastructure of each node (expert) is diverse and largely unknown
- The intended / ultimate user population is unknown, but OPNAV/N87 is certain it will be a large population (several hundred)
- File and information sharing is needed
- Asynchronous communication needs to be more effectively employed
- The application should be flexible to growth
- Control, Access and Sensitivity are major issues

Utilizing the analysis of International Bench for the development of the Maritime Interdiction Operations (MIO) Bench proved to be challenging due to the infancy of International Bench versus the maturity of the MIO planner's community. The MIO experiments will continue to flourish and provide an excellent opportunity for testing of a variety of means to manage communications with experts in geographically distributed collaborative networks. To ensure its success, the MIO Bench needs a team of advocates that can effectively balance the social and technological requirements necessary to make it a success. The MIO Bench is intended to assist in managing communications with experts and fill the need for information and knowledge flows among the experts participating in geographically distributed collaborative networks. The ideas and analysis presented in this chapter should be utilized as a starting point and applied for planning immediately.

A. INTERNATIONAL BENCH RECOMMENDATIONS

In conclusion of the analysis, the following recommendations are provided to spur further discussion and consideration for the development of the International Bench:

1. Development Approach

There are three main software development approaches (e.g., waterfall, spiral, or iterative). The interviews and analysis conducted found that it is best to find quick victories. In other words, field a capability that will allow members to use and gain a success story. Many members recommended this during the interviews. Additionally, from experience, Wenger, McDermott and Snyder (2005) recommend achieving quick victories early on for a CoP. This approach also provides relatively quick feedback useful to assess if the project is meeting the needs of the user before all resources, time, and effort are spent. Therefore, toward quick victories, it was recommended that the development effort take an iterative development approach. Develop small segments (i.e., functionalities, user interface, or content), test it, field it as soon as feasible, and seek immediate user feedback. This approach allows for immediate value to be added to the system. If iteration is determined to not add value, then it can quickly be considered for deprecation.

2. Current Application

Much effort and thought has been invested into the current pilot project developed by SPAWAR System Center – San Diego. A case was made early on to consider alternative technologies (i.e., a Service Oriented Architecture using Oracle portal technologies). However, after further thought and learning, such a leap would not be beneficial primarily because portal technologies were determined to better fit an organizational enterprise environment, which the SCC is not. Although there are other viable vendor solutions, International Bench stands to benefit more from the flexibility, expertise, responsiveness, and support a government laboratory offers. With this benefit the development can better apply an iterative approach, apply redesigns, and adjust requirements at a lower cost. Further, the current application is extensible and functionally sufficient for an initial launch. Therefore, the current application should be

used, further developed, and iteratively improved using the recommendations and considerations provided in this evaluation. Figure 15 shows the current application at the time of this analysis.

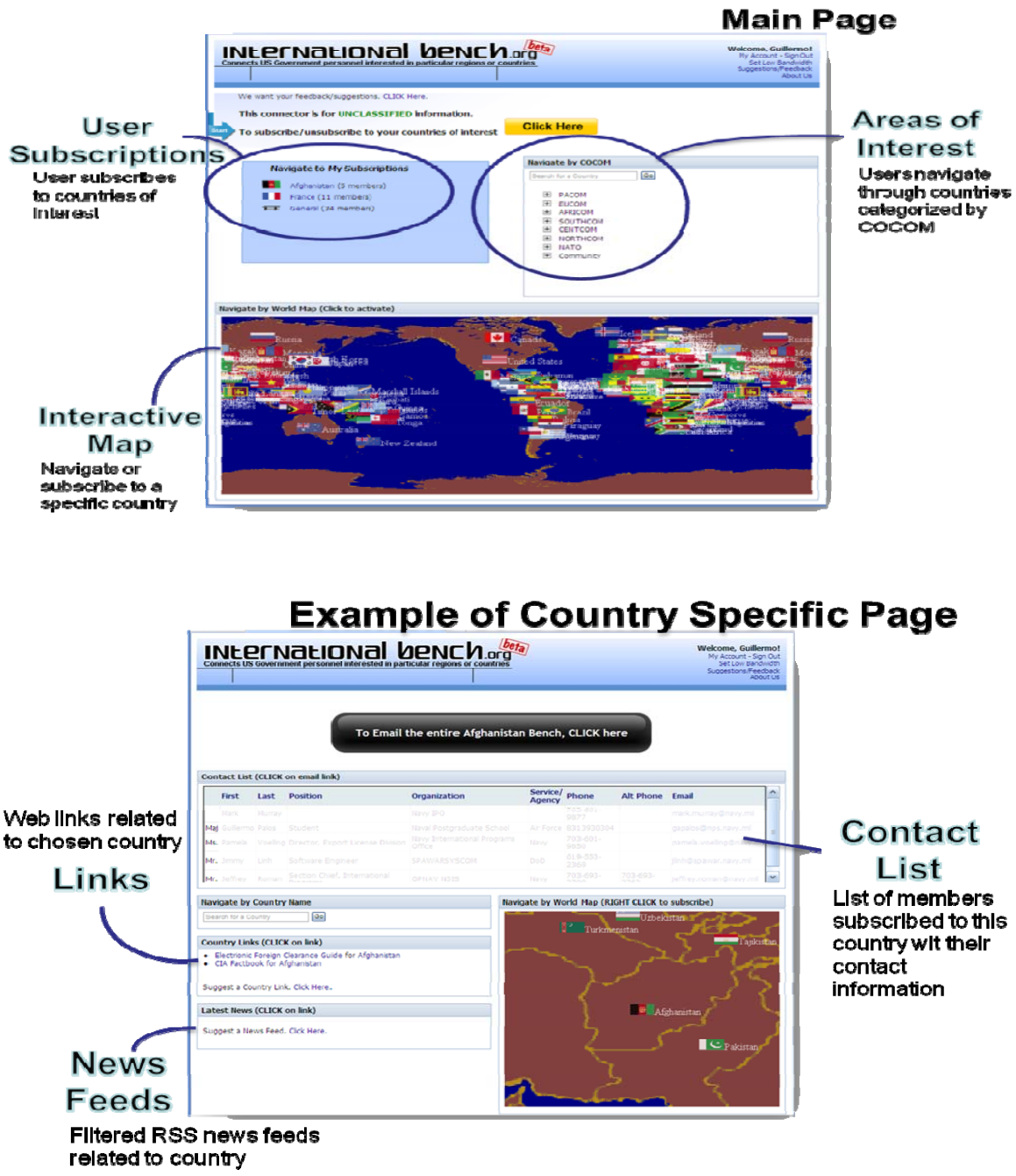
Main Page
International Bench.org
User Subscriptions
User subscribes to countries of interest
Areas of Interest
Users navigate through countries categorized by COCOM
Interactive Map
Navigate or subscribe to a specific country
Example of Country Specific Page
To Email the entire Afghanistan Bench, CLICK here
Web links related to chosen country
Links
Contact List
List of members subscribed to this country wit their contact information
News Feeds
Filtered RSS news feeds related to country

Figure 15. SSC-SD developed "International Bench" pilot project (From: http://web.internationalbench.org, retrieved on September 13, 2007)

3. Developmental Considerations

Referencing the iterative development approach recommended, this suggestion is offered to provide specific improvements believed to benefit the project immediately, in the short-term, in the mid-term, and in the long-term:

a. Immediate Iteration

- SNR formalize the Purpose and Vision for this project. Additionally, add the vision as a "banner" on the International Bench main page. Add the purpose in a prominent location on the main page. By doing so, the members are reminded of what the International Bench is all about. During the review of CoPs, a common thread found in successful CoPs was the prominence and visibility given to the reason why the CoP existed.

- User Feedback on the Pilot project. A critical step in the iterative development process is user feedback. Each time a development is fielded, SNR should seek user feedback. This can be conducted through interviews, surveys or casual discussion. An online survey capability can be added to the International Bench in the future to simplify this requirement. Evaluate the feedback for use in the development of the next iteration, to fix a current fielding or to deprecate items.

- Usability Evaluation. Usability relates to the ease with which members are able to use the system. This also refers to the effective use of "real-estate" on the screen, the relevance of items, and the general look and feel of the user interface. Usability is an important matter. It is a critical matter for a system that is used voluntarily (e.g., Google, YouTube, FaceBook, etc…). Bad usability will keep people away. Therefore, an impartial party should be employed (i.e., randomly pick users or nonusers) to evaluate the International Bench for its general usability. For example, the current application utilizes

an interactive map. This may serve as an initial stimulus and an attention getter for new users. It may, however, become an annoyance for someone who uses the system day-to-day and finds that it just gets in the way. The user interface should be designed for day-to-day users and consider factors that would best complement the natural way members work. Fluff and attention getters are not needed in a professional, not for profit, user environment.

b. Short-term Iteration (0 to 6 months out)

- Robust User Profiles. The purpose of the International Bench is to manage communications with experts in the SCC. More specifically, it is envisioned to connect people with issues, problems, or questions with people with insight, experience, or options. The member profile is a power tool that can be used toward this. In an information-focused system, the objective is to connect people with information. Therefore, user profiles contain basic information such as name and email. In a knowledge-focused system, the user profiles must be more robust and descriptively rich. CompanyCommand.com (Dixon, 2005), a successful CoP, uses an extensive profile where users self identify their areas of expertise, interest, and experience. Others, such as SWO.net, add organizational information, preferences on how they like to be contacted, and much more. Complemented with a searchable query and report capability, robust user profiles are powerful when seeking to connect with someone to solve a problem. Therefore, such a capability should be developed in the next iteration. Dynamic web-enable database procedures are useful to easily achieve this type of capability.

- Document Sharing. Even in a knowledge-focused CoP, information is important because it also enables learning. Document sharing is a natural and familiar way people work. It adds a collaborative element

to the system. Many members interviewed expect to have this capability in an initial iteration. Therefore, this basic functionality should be included in a short-term iteration.

- "SC-Wiki." Recall that a Wiki (i.e., What I Know Is…) is an editable web page that anyone with access can update using a common web browser. Wikis are useful to establish common meaning about ideas, terms, concepts, and history of things that are relevant to the community. For example, the Naval Postgraduate School saw a need to bring together a growing disparate understanding of Network Centric Operations across DoD and initiated a Wiki to create a forum to coalesce understandings to achieve common meaning. The SCC can benefit from such an idea. It can serve to create and share meaning, be used as a working reference, and be allowed to evolve with changes in the environment. Although this does not fit as one of the subsystems of the conceptual design, it is still recommended because it is open source technology and relatively easy to implement.

c. Mid-term Iteration (6 to 12 months on)

- Vendor Solutions. In order to consider long-term sustainment and maintenance, and the need to employ more complicated capabilities, SNR should consider possible vendor specific technologies and services. For example, it may be more cost effective to purchase a proprietary Discussion Forum application that can be added to the current capability as an add on (i.e., connected as a web-service or a URL link to a stand-alone application). There are vendors available who are already working on Army and Air Force CoPs.

- Discussion Forums. This perhaps, along with the user profiles and information repositories, is a key functionality in any CoP system. A discussion forum is a means for a CoP to communicate and interact asynchronously. The discussions are persistent, broadcasted for all to

see, and can be reused and expanded to meet the natural and evolving needs of the community members. This is a powerful tool that can be used to promote the asking of questions where the broader community may also benefit from viewing the responses. Reference the work by Dixon et al. (2005) to see how Army company commanders have effectively utilized discussion forums. Consideration should be given to a vendor solution.

- Organizational Profiles. Similar to the User Profiles that are designed to give a description, purpose, and vision of the organization, organizational profiles would expand the richness of the member environment. One member interviewed, suggested that such a capability would be beneficial and useful. Organizational profiles in this community would be valuable due to the quantity and diversity of the organizations. Indeed, there is a sea of organizations. Therefore, this functionality could be employed in the same fashion as the User Profiles. However, consideration must be made of how to keep organizational content current.

d. Long-Term Iteration (beyond 12 months)

- Yellow Pages. A Yellow Pages application offers the CoP member a means to connect with other members. It utilizes the member profiles, previously discussed, that include such information as: areas of expertise, assignments, areas of interest and others in a form-factor where the information can be queried and manipulated in advanced ways. They further provide the ability to map expertise across the community to more easily identify a potential constituency for an issue or problem to solicit feedback or request collaboration. The use of Yellow Pages is an emerging Knowledge Management technology that

requires further study. However, it may be a worthy future application to add to the power of the user profiles. Therefore, this technology should be studied and considered in the long-term.

- Blog Application. Blogs are similar to Discussion Forums in functionality and technology, however they are used for personal broadcast of messages and communication. In a CoP, they are useful for broadcasting leadership, functional or organizational messages. They also allow for readers to comment, affirm or seek clarification to messages in the form of a threaded discussion. Although the same technology used for a Discussion Forum can be used in a blog format, simple dynamic web-enabled database technology can also be used for more primitive, but effective, blogs.

B. MARITIME INTERDICTION OPERATIONS BENCH RECOMMENDATIONS

In conclusion of the analysis, highlighted here are several recommendations that were made to spur further discussion and consideration for MIO Bench development. Although a number of the recommendations mirror those made for the continued development of International Bench, the prior success of the planning done through various forms of collaboration, primarily e-mail, were taken into account for MIO Bench. Additionally, because the MIO planner's community is already a collaborative network, the development of the MIO Bench will enhance their capability.

1. Development Approach

Of the three recommended software development approaches (e.g., waterfall, spiral, or iterative), the focus remains on iterative, similar to International Bench in regards to finding quick victories. In this venue, it is best to field a capability that will allow members to use and gain a success story. As a reminder, this approach provides relatively quick feedback useful to assess if the project is meeting the needs of the user before all resources, time, and effort are exhausted.

2. Current Application

There is some danger in relying too much on the current pilot project developed by SPAWAR System Center – San Diego for International Bench. Because MIO Bench has adopted the same application, it has inherited its successes along with its flaws. Unlike the Navy's SCC organization that is not inherently a networked organization, the MIO planners, all within their stovepipe organizations, form a network to accomplish the objectives of MIO. Therefore, they already understand the importance of networking and would not want to be potentially hindered due to the wrong application and strategy being employed. Despite this concern, the current application should not be changed, just closely monitored for its effectiveness. The MIO Bench stands to benefit from the flexibility, expertise, responsiveness and support a government laboratory offers. With this benefit the development can better apply an iterative approach, apply redesigns, and adjust requirements at a lower cost. Further, the current application is extensible and functionally sufficient for an initial launch. Therefore, this analysis recommends the current application be used, further developed, and iteratively improved using the recommendations and considerations provided in this thesis. The following screen shots demonstrate the current status of the MIO Bench as well as the similarity it shares with International Bench.

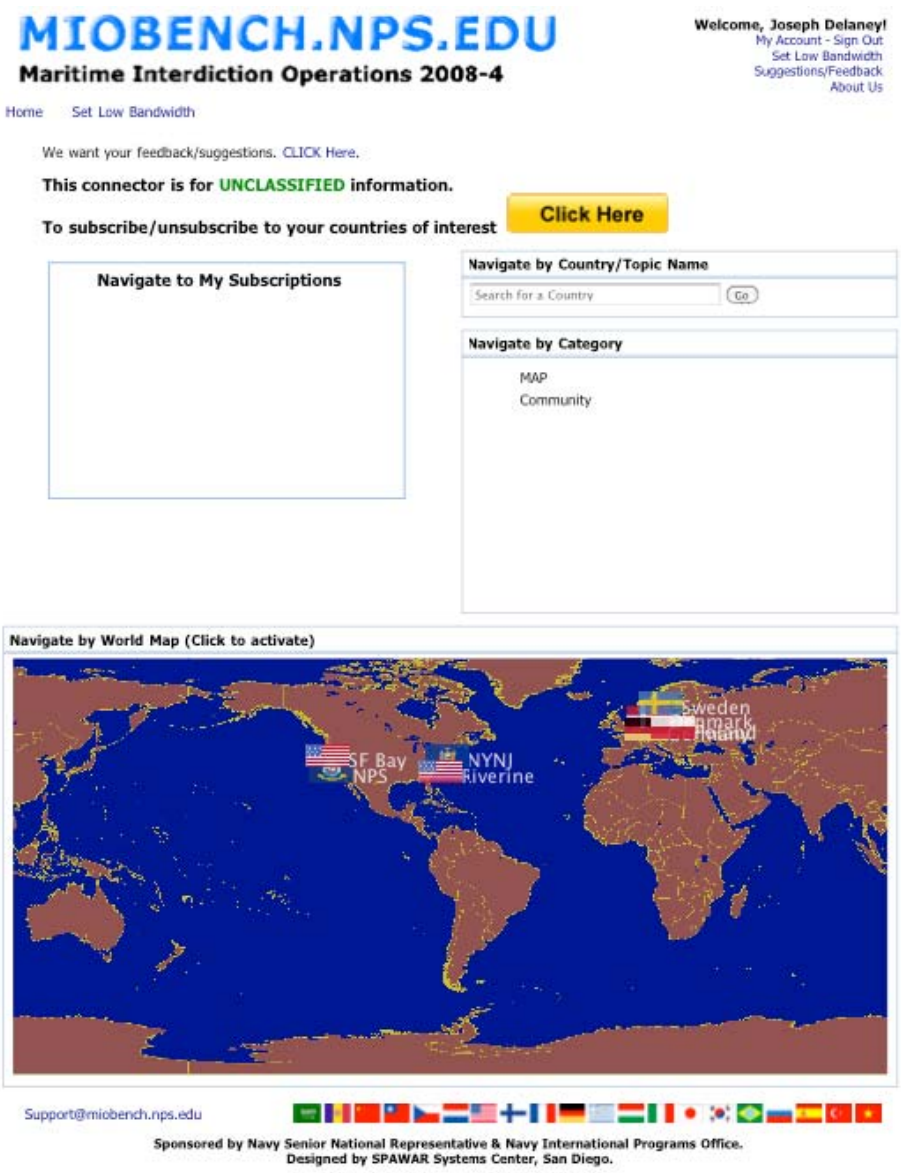

Figure 16. MIO Bench High Bandwidth Home Page retrieved March 3, 2009 from https://www.miobench.nps.edu

Once a member has accessed the MIO Bench, they can access individual portions of the collaborative environment. An example of the Communications portion of the MIO Bench is shown below in Figure 17.

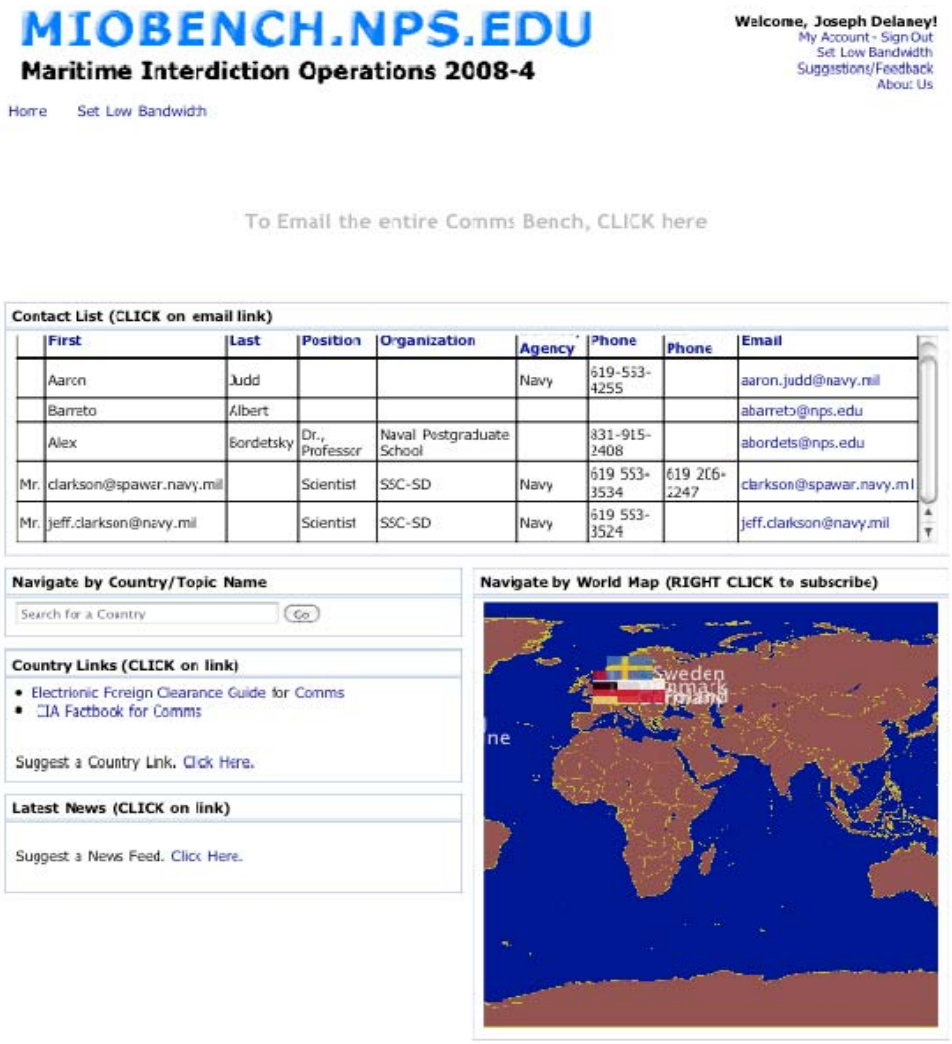

Figure 17. MIO Bench Communications Page retrieved March 3, 2009 from https://www.miobench.nps.edu

3. Developmental Considerations

Unlike the recommendations provided from the analysis for International Bench, the MIO timeline is significantly shorter with MIOs occurring every six months. Any recommendations made should be susceptible to rapid integration to prove its success. Therefore, a number of the recommendations previously made have been re-categorized and summarized for immediate inclusion into the MIO Bench development, or in some cases completely eliminated.

- Formalize the Purpose and Vision for this project. Additionally, add the vision as a "banner" on the MIO Bench main page. Add the purpose in a prominent location on the main page. By doing so, the members are reminded of what the MIO Bench is all about.
- User Feedback on the Pilot project. A critical step in the iterative development process is user feedback. This can be conducted through by interviews, surveys or casual discussion. An online survey capability can be added to simplify this requirement. Evaluate the feedback for use in the development of the next iteration, to fix a current fielding or to deprecate items.
- Usability Evaluation. An impartial party should be employed (i.e., randomly pick users or nonusers) to evaluate the MIO Bench for its general usability. The user interface should be designed for day-to-day users and consider factors that would best complement the natural way members work.
- Robust User Profiles. The purpose of the MIO Bench is to connect people together. More specifically, it is envisioned to connect people with issues, problems, or questions with people with insight, experience or options. The member profile is a power tool that can be used toward this. In an information-focused system, the objective is to connect people with information. Therefore, user profiles contain basic information (i.e., name and email). In a knowledge-focused system, the user profiles must be more robust and descriptively rich.
- File Sharing. Even in a knowledge-focused CoP, information is important because it also enables learning. Document sharing is a natural and familiar way people work. It adds a collaborative element to the system.
- "MIO-Wiki." Wikis are useful to establish common meaning about ideas, terms, concepts and history of things that are relevant to the community.

- Discussion Forums. This perhaps, along with the user profiles and information repositories, is a key functionality in any CoP system. A discussion forum is a means for a CoP to thematically communicate and interact asynchronously.

- Organizational Profiles. Similar to the User Profiles, organizational profiles would expand the richness of the member environment.

- Yellow Pages. A Yellow Pages application offers the CoP member a means to connect with other members. It utilizes the member profiles, previously discussed, that include such information as: areas of expertise, assignments, areas of interest and others in a form-factor where the information can be queried and manipulated in advanced ways.

- Blog Application. Blogs are similar to Discussion Forums in functionality and technology, however they are used for personal broadcast of messages and communication. In a CoP, they are useful for broadcasting leadership, functional or organizational messages. They also allow for readers to comment, affirm or seek clarification to messages in the form of a threaded discussion.

C. PLATFORM RECOMMENDATIONS BEYOND "THE BENCH" CONFIGURATION

In conclusion of the analysis, highlighted here are two recommendations that are currently being widely explored by organizations seeking to manage communications with experts in geographically distributed collaborative networks. The analysis done on these two platforms show that both of them could be used, along with the social criteria identified throughout this thesis, to address the hypothesis of this thesis. Following the analysis of International Bench, Chapter III, and Marine Interdiction Operations (MIO) Bench, Chapter IV, this Chapter concludes this thesis and provides a brief look of alternative technologies. To fit into the discussions taken place in the earlier analysis, any recommended technologies must encapsulate the social and technical considerations discussed in great detail to this point. Two such technologies with the potential to

accomplish this are Microsoft's Groove and Palantir (Bordetsky, 2009). Although Groove was discussed briefly in the analysis criteria section of Chapters III and IV, a detailed review of Groove, along with an overview of Palantir, is provided in the following paragraphs.

1. Groove

This author was first exposed to Microsoft's Office Groove in Naval Postgraduate School Information Science Course 4188 Collaborative Technologies. During the course, Groove was used extensively for collaboration to accomplish the course requirements. Groove is a collaboration tool developed specifically to help teams work together dynamically and effectively. The focus of its development was on geographically separated teams or team members who may work for different organizations, work remotely, or frequently work offline. Utilizing Groove to manage communications among experts can save time, increase productivity, and strengthen the quality of the connections formed in this collaborative environment (Microsoft, 2009). This tool appears to seamlessly fit the network structure of geographically distributed experts and their collaborative networks. Figure 18 below shows a screen shot of Microsoft Groove 2007; although, Groove offers a number of features that may not appear to be obvious here (i.e., chat, video, discussion board, and file repository).

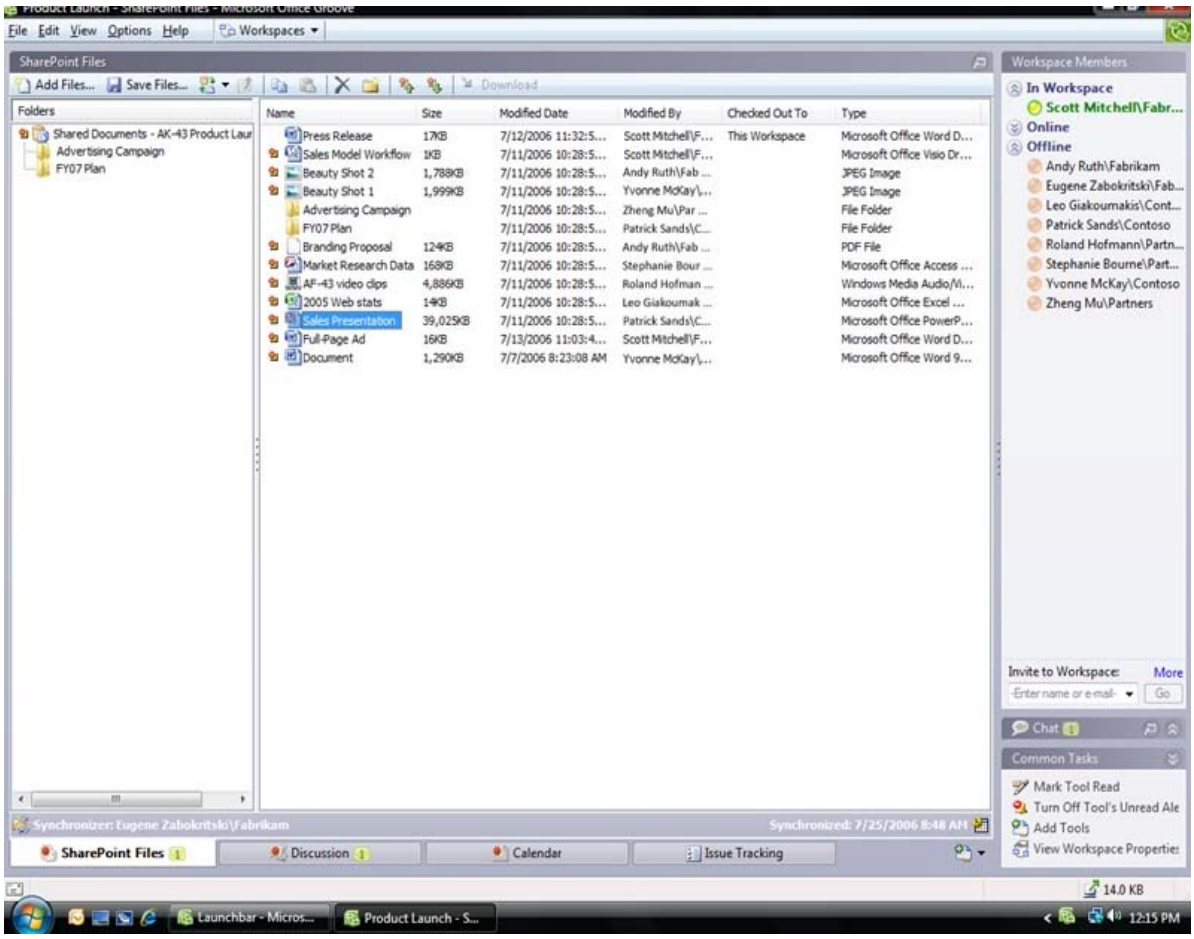
File Edit View Options Help
Workspaces
SharePoint Files
Add Files... Save Files...
Folders
Shared Documents - AK-43 Product Laur
Advertising Campaign
FY07 Plan
Name
Size
Modified Date
Modified By
Checked Out To
Type
Press Release 17KB 7/12/2006 11:32:5... Scott Mitchell\F... This Workspace Microsoft Office Word D...
Sales Model Workflow 1KB 7/11/2006 10:28:5... Scott Mitchell\F... Microsoft Office Visio Dr...
Beauty Shot 2 1,788KB 7/11/2006 10:28:5... Andy Ruth\Fab ... JPEG Image
Beauty Shot 1 1,999KB 7/11/2006 10:28:5... Yvonne McKay\... JPEG Image
Advertising Campaign 7/11/2006 10:28:5... Zheng Mu\Par ... File Folder
FY07 Plan 7/11/2006 10:28:5... Patrick Sands\C... File Folder
Branding Proposal 124KB 7/11/2006 10:28:5... Andy Ruth\Fab ... PDF File
Market Research Data 168KB 7/11/2006 10:28:5... Stephanie Bour ... Microsoft Office Access ...
AF-43 video clips 4,886KB 7/11/2006 10:28:5... Roland Hofman ... Windows Media Audio/Vi...
2005 Web stats 14KB 7/11/2006 10:28:5... Leo Giakoumak ... Microsoft Office Excel ...
Sales Presentation 39,025KB 7/11/2006 10:28:5... Patrick Sands\C... Microsoft Office PowerP...
Full-Page Ad 16KB 7/13/2006 11:03:4... Scott Mitchell\F... Microsoft Office Word D...
Document 1,290KB 7/7/2006 8:23:08 AM Yvonne McKay\... Microsoft Office Word 9...
Workspace Members
In Workspace
Scott Mitchell\Fabr...
Online
Offline
Andy Ruth\Fabrikam
Eugene Zabokritski\Fab...
Leo Giakoumakis\Cont...
Patrick Sands\Contoso
Roland Hofmann\Partn...
Stephanie Bourne\Part...
Yvonne McKay\Contoso
Zheng Mu\Partners
Invite to Workspace: More
Enter name or e-mail Go
Chat
Common Tasks
Mark Tool Read
Turn Off Tool's Unread Ale
Add Tools
View Workspace Properties
Synchronizer: Eugene Zabokritski\Fabrikam
Synchronized: 7/25/2006 8:48 AM
SharePoint Files 1
Discussion 1
Calendar
Issue Tracking
14.0 KB
Launchbar - Micros...
Product Launch - S...
12:15 PM

Figure 18. Microsoft Groove 2007 Screen Shot. (From: Microsoft, 2009)

As shown during the analysis criteria early on, the use of Groove in CENETIX is not new. Quarles (2008) notes that as early as 2003, it was commonly understood by NPS researchers that the inclusion of a Commercial Off-the-Shelf collaboration solution was going to play a pivotal part in any feasible solution to the management of communications in the geographically distributed MIO collaborative network hurdle. A benefit of the program is the ability to instant message individual participants within the experiment. It is also advantageous to have all of the members of the workspace listed along the left side of the window, as seen in Figure 19, to include their activity status. The functionality of Groove has periodically been hampered by an unexpected learning curve during experiments. This learning involved the installation of the program on remote computers and the method used to join the experimentation workspaces. The

review of Quarles (2008) and personal analysis demonstrated that the installation problems come about because of the registration keys and invitations used to install the program and to join specific the workgroups could be resolved through automation of key distribution. Although, installation is dependent on a number of different factors (i.e., platform, human interaction) that may continue to introduce unknown variables.

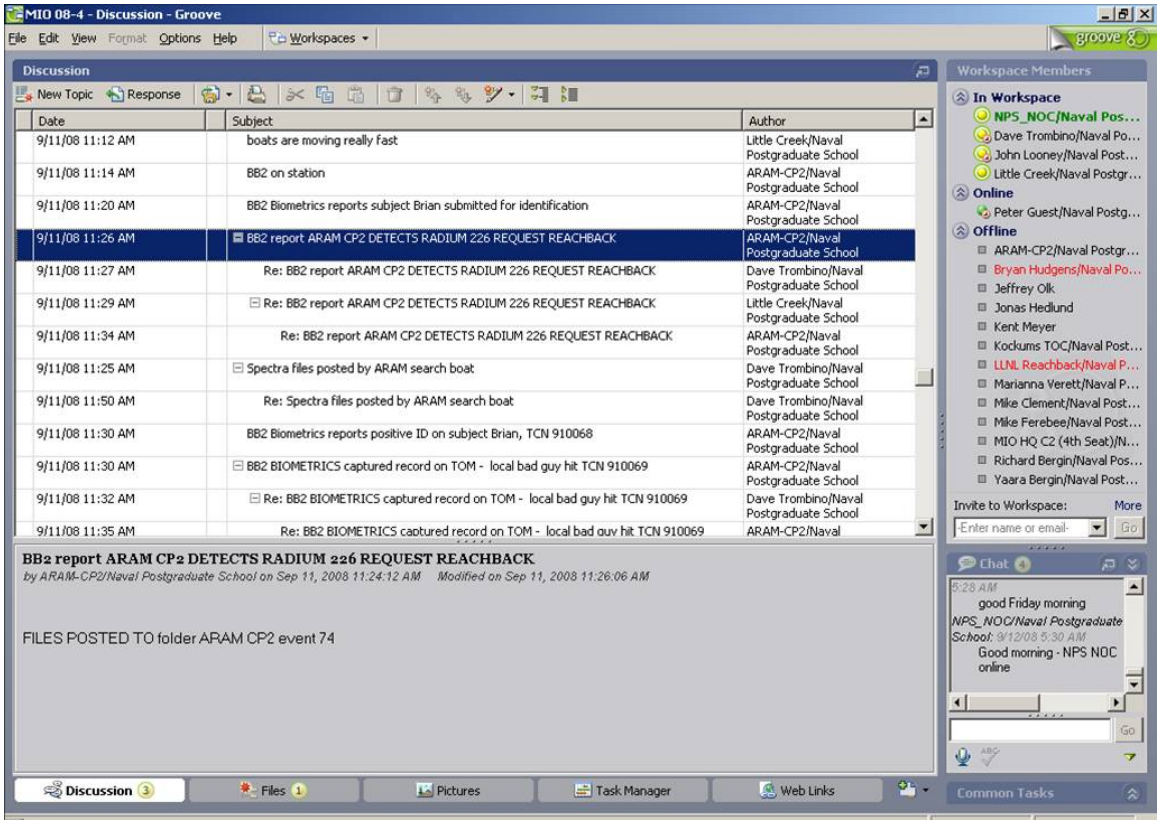
MIO 08-4 - Discussion - Groove
File Edit View Format Options Help
Workspaces
groove
Discussion
New Topic
Response
Date
Subject
Author
9/11/08 11:12 AM
boats are moving really fast
Little Creek/Naval Postgraduate School
9/11/08 11:14 AM
BB2 on station
ARAM-CP2/Naval Postgraduate School
9/11/08 11:20 AM
BB2 Biometrics reports subject Brian submitted for identification
ARAM-CP2/Naval Postgraduate School
9/11/08 11:26 AM
BB2 report ARAM CP2 DETECTS RADIUM 226 REQUEST REACHBACK
ARAM-CP2/Naval Postgraduate School
9/11/08 11:27 AM
Re: BB2 report ARAM CP2 DETECTS RADIUM 226 REQUEST REACHBACK
Dave Trombino/Naval Postgraduate School
9/11/08 11:29 AM
Re: BB2 report ARAM CP2 DETECTS RADIUM 226 REQUEST REACHBACK
Little Creek/Naval Postgraduate School
9/11/08 11:34 AM
Re: BB2 report ARAM CP2 DETECTS RADIUM 226 REQUEST REACHBACK
ARAM-CP2/Naval Postgraduate School
9/11/08 11:25 AM
Spectra files posted by ARAM search boat
Dave Trombino/Naval Postgraduate School
9/11/08 11:50 AM
Re: Spectra files posted by ARAM search boat
Dave Trombino/Naval Postgraduate School
9/11/08 11:30 AM
BB2 Biometrics reports positive ID on subject Brian, TCN 910068
ARAM-CP2/Naval Postgraduate School
9/11/08 11:30 AM
BB2 BIOMETRICS captured record on TOM - local bad guy hit TCN 910069
ARAM-CP2/Naval Postgraduate School
9/11/08 11:32 AM
Re: BB2 BIOMETRICS captured record on TOM - local bad guy hit TCN 910069
Dave Trombino/Naval Postgraduate School
9/11/08 11:35 AM
Re: BB2 BIOMETRICS captured record on TOM - local bad guy hit TCN 910069
ARAM-CP2/Naval
BB2 report ARAM CP2 DETECTS RADIUM 226 REQUEST REACHBACK
by ARAM-CP2/Naval Postgraduate School on Sep 11, 2008 11:24:12 AM Modified on Sep 11, 2008 11:26:06 AM
FILES POSTED TO folder ARAM CP2 event 74
Workspace Members
In Workspace
NPS_NOC/Naval Pos...
Dave Trombino/Naval Po...
John Looney/Naval Post...
Little Creek/Naval Postgr...
Online
Peter Guest/Naval Postg...
Offline
ARAM-CP2/Naval Postgr...
Bryan Hudgens/Naval Po...
Jeffrey Olk
Jonas Hedlund
Kent Meyer
Kockums TOC/Naval Post...
LLNL Reachback/Naval P...
Marianna Verett/Naval P...
Mike Clement/Naval Post...
Mike Ferebee/Naval Post...
MIO HQ C2 (4th Seat)/N...
Richard Bergin/Naval Pos...
Yaara Bergin/Naval Post...
Invite to Workspace:
More
Enter name or email
Go
Chat
5:28 AM
good Friday morning
NPS_NOC/Naval Postgraduate School: 9/12/08 5:30 AM
Good morning - NPS NOC online
Discussion 3
Files 1
Pictures
Task Manager
Web Links
Common Tasks

Figure 19. Microsoft Groove 2007 Screen Shot. (From: Chen, 2009)

2. Palantir

Unlike Microsoft's Groove, this author was exposed to Palantir during the research phase of this thesis. Mr. Gabe Rosen[4] provided documentation and extensive

[4] Gabe Rosen is an embedded analyst with the Naval Postgraduate School's Common Operational Research Environment (CORE) Lab. He works for Palantir Technologies and an be reached at grosen@palantirtech.com.

video coverage to help frame the value of Palantir towards the management of communications with experts in geographically distributed collaborative networks. Prior to outlining the key features of Palantir, the following two video links are provided:

- http://www.palantirtech.com/government/videos/hezbollah/
    - An analysis of Hezbollah's global activity.
- http://www.palantirtech.com/government/videos/simba/
    - A walkthrough of many of the main analytic processes in Palantir, built into one workflow.

These links form a powerful graphical view of the full capabilities resident in the software. Palantir was developed for the U.S. government to be used at the strategic, operational, and tactical levels as a targeting and mission-planning platform. Despite this unique mission, the functions offered by Palantir provide a solid platform for managing communications with experts in geographically distributed collaborative networks. In the context of managing communications and supporting communication with the expert network, Palantir offers a powerful backend database and server architecture with an intuitive front end user interface designed to store, search and share knowledge and information. Data is integrated from multiple sources and can be utilized to provide a common overview resulting in trend analysis. This is particularly useful for developing a common picture of the communications occurring among experts in stove-piped organizations.

An initial analysis of Palantir proved to be well in line for supporting the community of experts identified early on. The remainder of the analysis focused on one key aspect of Palantir – its focus on understanding the human terrain Palantir (2008) states:

> As war-fighters interact with the population, they learn the key political, tribal, ethnic, and economic leaders and trends. Palantir allows all this data to be stored with pictures, summaries, notes and geo-referenced locations to be accessed by anyone at anytime, so you don't have to relearn the battlespace after a unit changeover. As a unit travels and operates in an area, detailed collection on every house, person or event can

> be captured and shared to discover connections and trends. Video feeds, Biometric data and evidence can be stored in Palantir with a geo-reference and date time group for geographic and temporal analysis. (Palantir, 2009)

This is an ideal demonstration of the power of the Palantir tool to capture data and provide valuable intelligence through the manipulation of that data. It also demonstrates the human-technical interaction consideration that went into the development of the technology. Because the social criteria needed was illustrated so clearly in Chapters III and IV, it is important any technology used to support managing communications have a solid data management plan. Palantir uses what they have termed as Revisioning Database technology where all data is tagged with an extensible set of metadata. Additionally, all changes to data can be tracked and revised. Most importantly, it is compatible with other types of formatted and unformatted data such as unstructured message traffic, structured identity data, link charts, spreadsheets, phone data, and documents. This data can be imported in any format (i.e., databases, seized media, emails, Excel, Word, PowerPoint, html, text, csv, xml, pdf, and more) (Palantir, 2008).

This analysis demonstrates that Palantir is a useful tool for managing communications with experts in geographically distributed collaborative networks. The last portion of the analysis performed on the capabilities of Palantir focused on its capabilities as a social network and link analyzer. Although this would appear to be the most critical area, other social network analysis tools are available on the market. By focusing on the other strengths of Palantir, but demonstrating that Palantir is also useful in this area, this thesis has shown that it has a wide degree of capabilities. Additionally, two screen shots of key functions within Palantir, Time Filtering and Flows are seen in Figures 20 and 21 below. Figure 20, Time Filtering, demonstrates a graph of a social network linked to a histogram allowing views to be filtered based on time frames. Figure 21 allows for the visualization of resources flowing between entities. The configurable threshold enables the filtering of key data (Palantir, 2008).

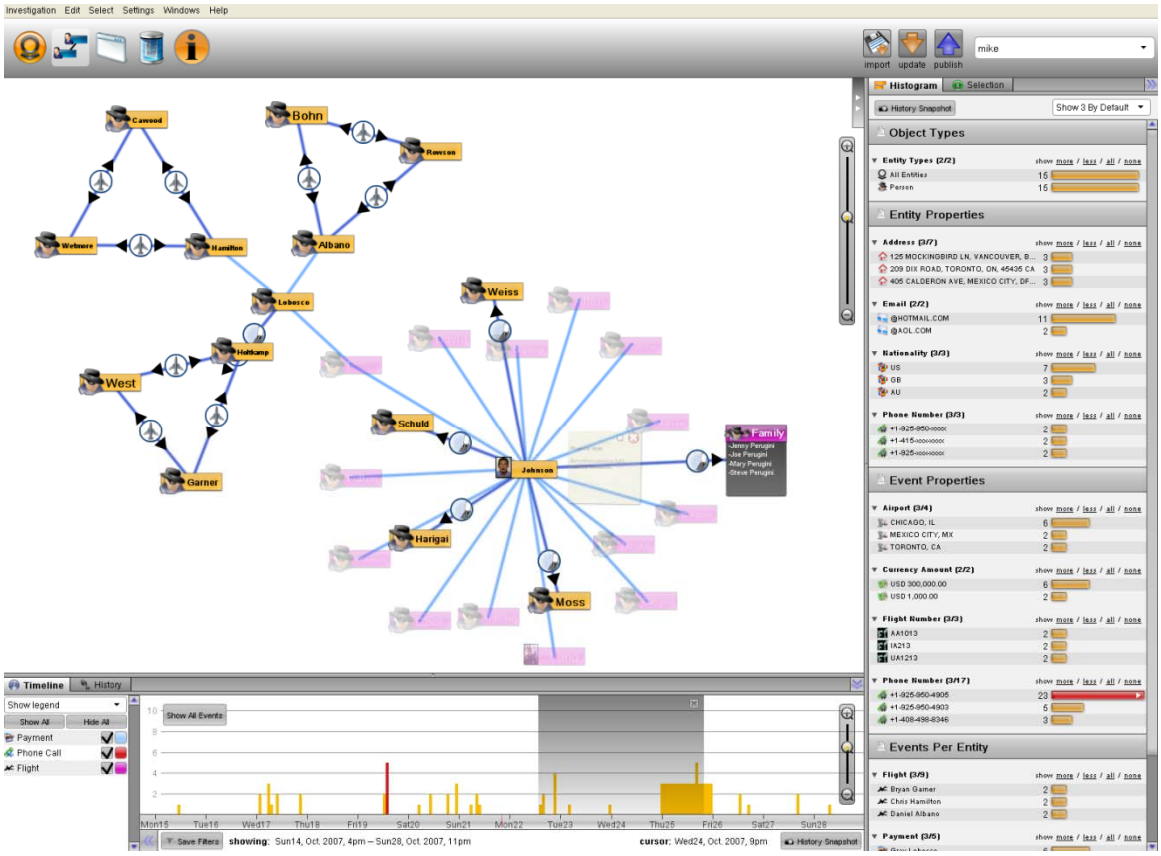

Figure 20. Time Filtering Screen Shot retrieved from http://www.palantirtech.com on February 20, 2009

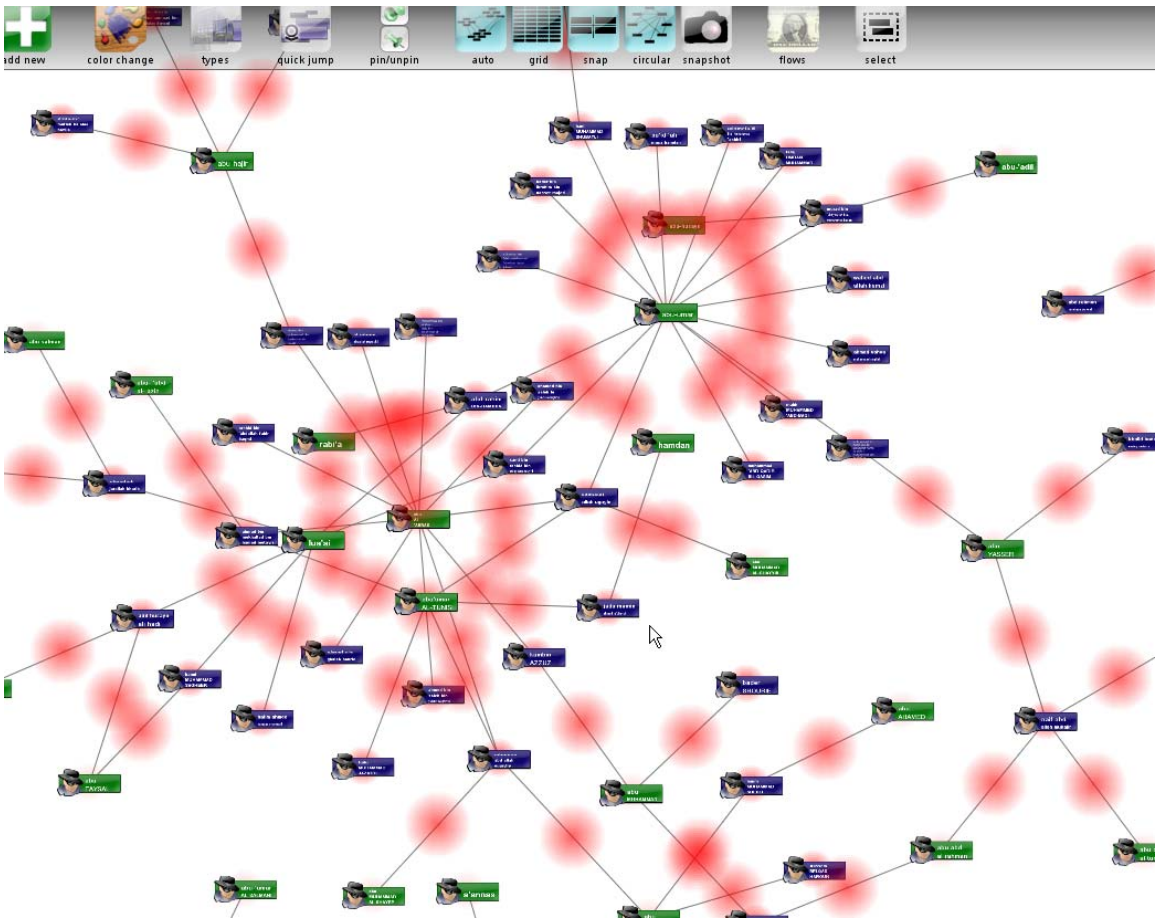

Figure 21. Flows Screen Shot retrieved from http://www.palantirtech.com on February 20, 2009

In summary, this thesis has demonstrated that communications with experts in geographically distributed collaborative networks can be managed. It has shown both the social and technological considerations that must be considered to be successful. In closing, a decision must be made regarding the technological platform recommended for managing communications in the MIO planner's community, the focal organization of this thesis. Based on the analysis conducted in this thesis, Palantir appears to provide the most functionality to support the MIO community. Before a final decision is made, actions need to be taken that are beyond the scope of this thesis. The MIO Bench server is currently located in the NPS' Information Technology and Computer Support server room. It is technically maintained by SSC-SD, Mr. Aaron Judge. Currently, the contract

to support International Bench, and thus MIO Bench, is coming to a close. SSC-SD, in conjunction with the Director of CENETIX must come to a conclusion regarding the future of the contract. The MIO planner's community needs a place where they can come together, utilizing technology developed to enhance social skills, and continue to excel. CENETIX should sponsor a group of thesis students who can utilize this research, the extensive research done by others, to include Palos (2007), and position themselves to develop a long-term solution.

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